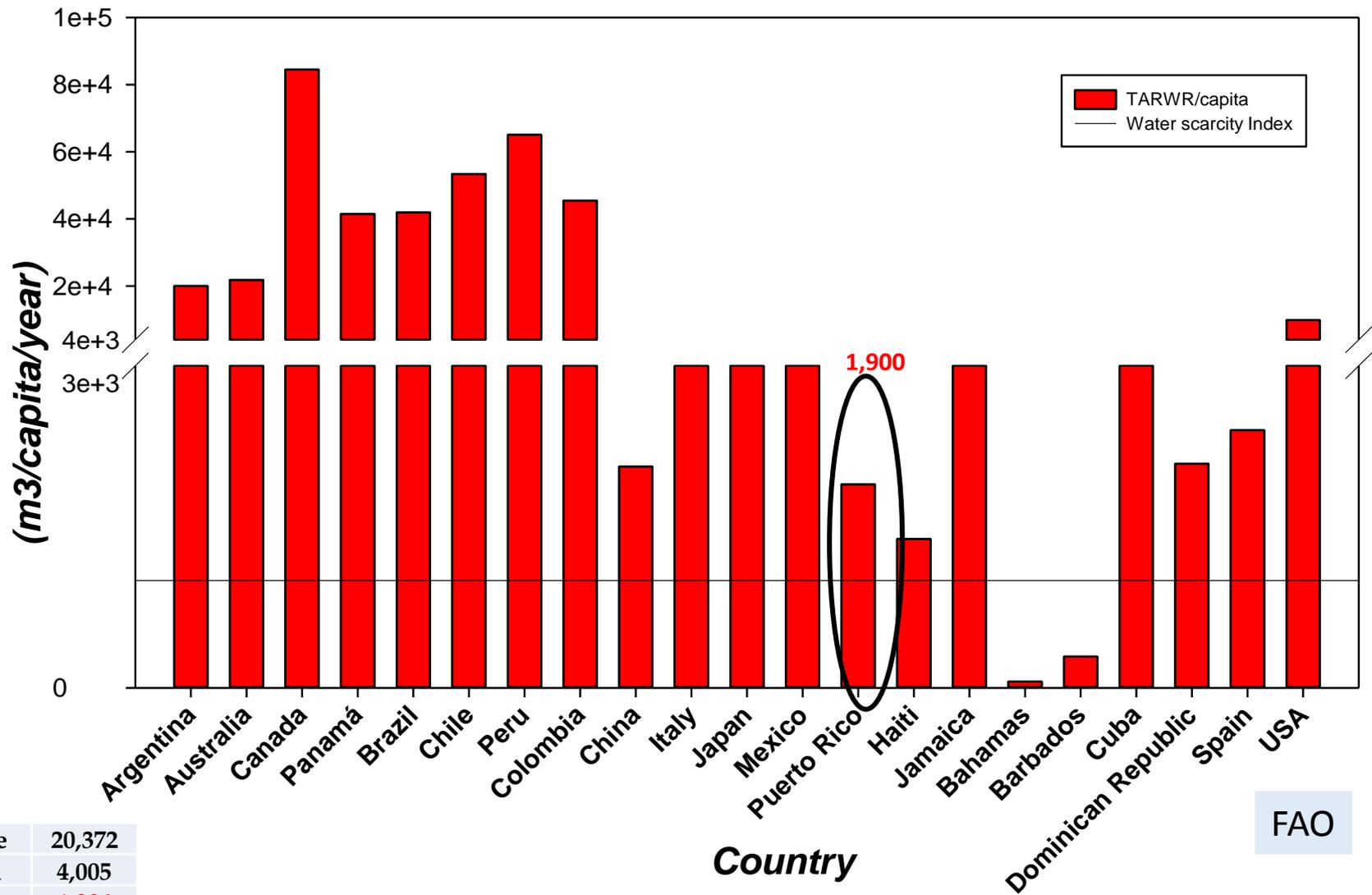


Waterbodies of Puerto Rico: Distribution, Uses and Constraints



G. A. Martínez, Ph.D.

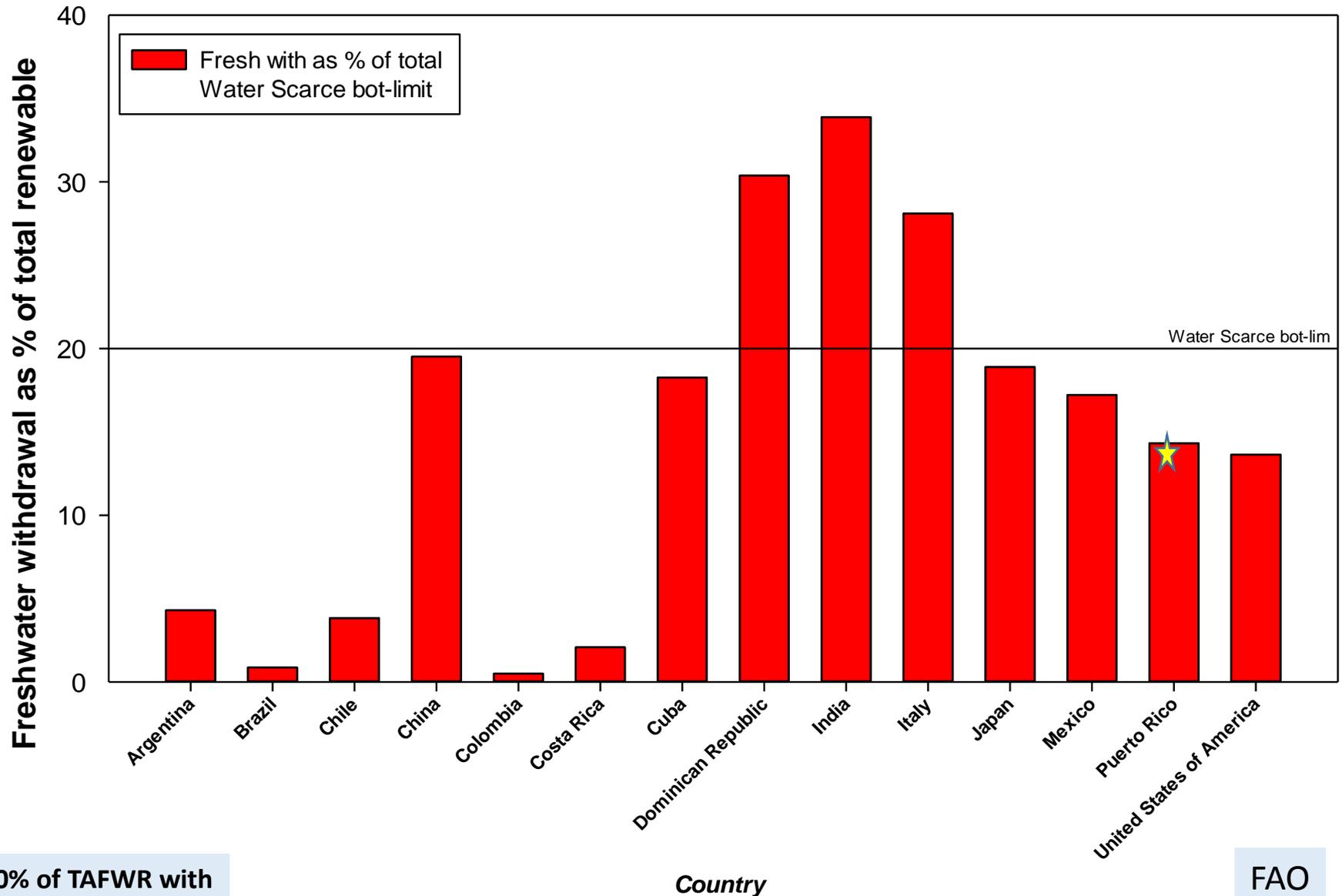
Total Renewable Fresh Water Resource/capita



Average	20,372
Median	4,005
P₃₀	1,904
P ₇₅	15,973
P ₉₀	48,295
P. Rico	1,895

FAO

Freshwater withdrawal



60% of TAFWR with
no saline water

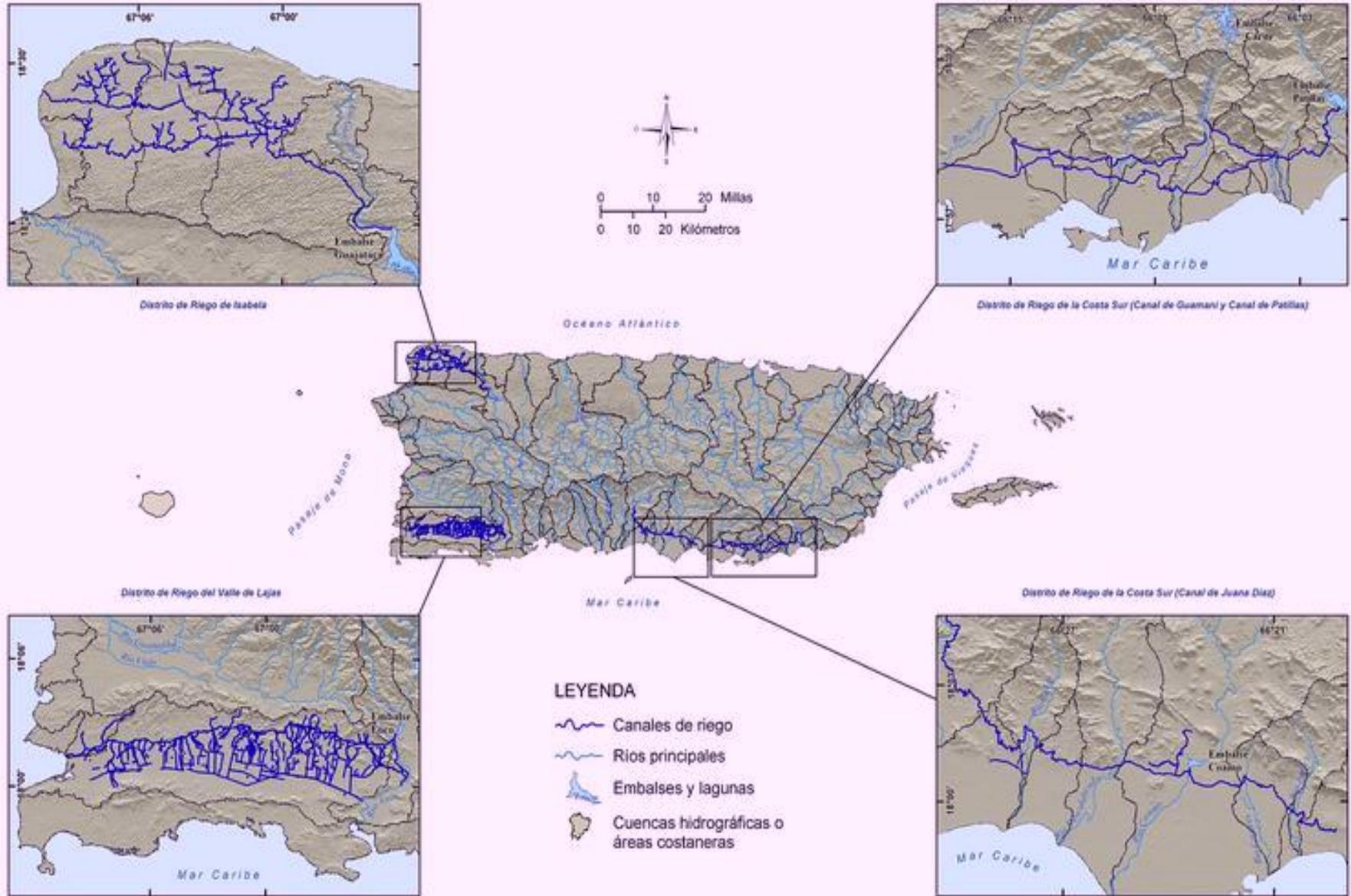
FAO



- 134 watersheds
 - 54 major (10 minor)
 - 70 coastal

- 54 watersheds
 - 32 drain 90% of superficial land
 - 6 drain 37% of superficial land

Agriculture as a driver of Water Distribution Infrastructure in PR

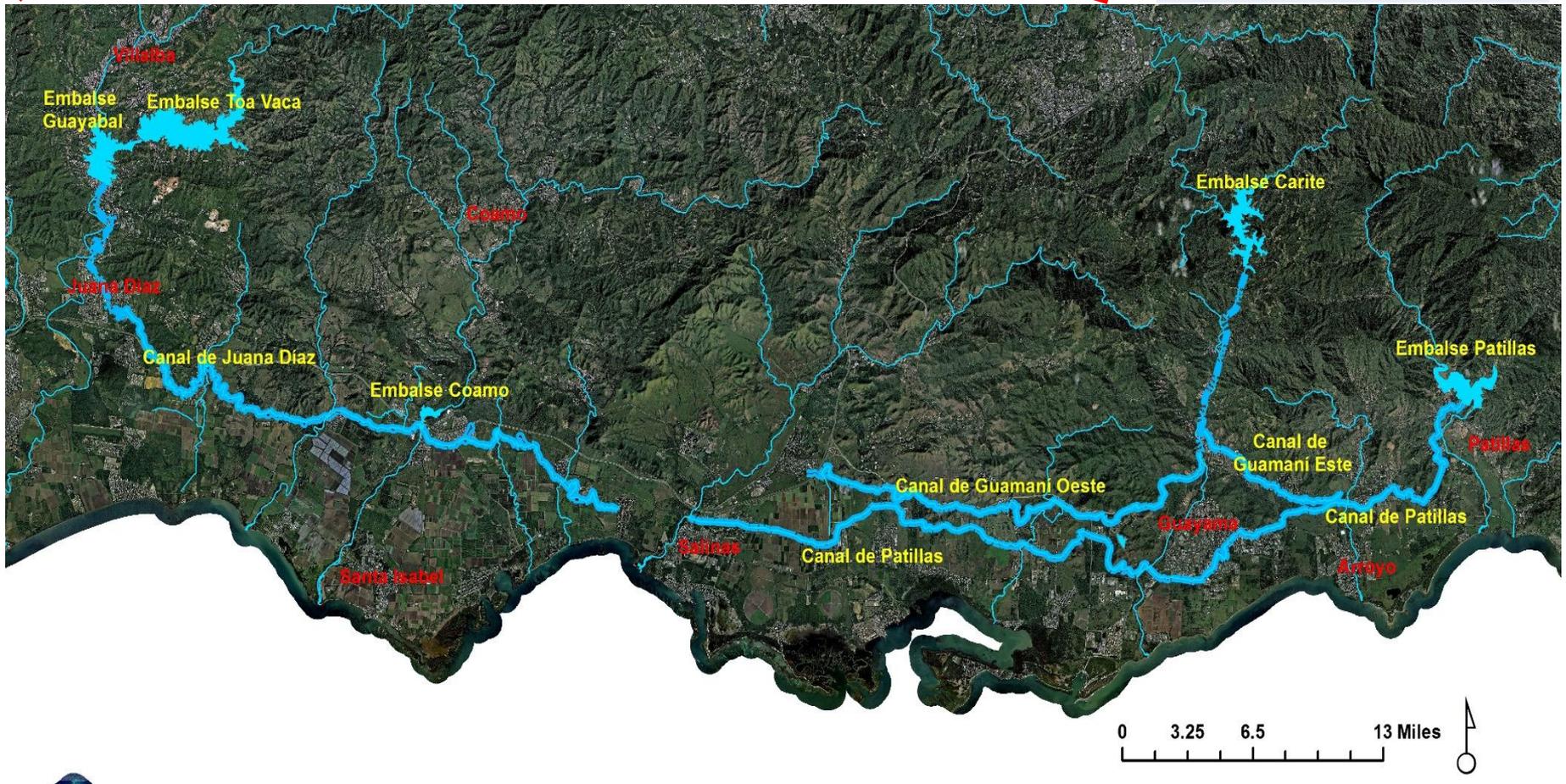


Costa Sur Water District



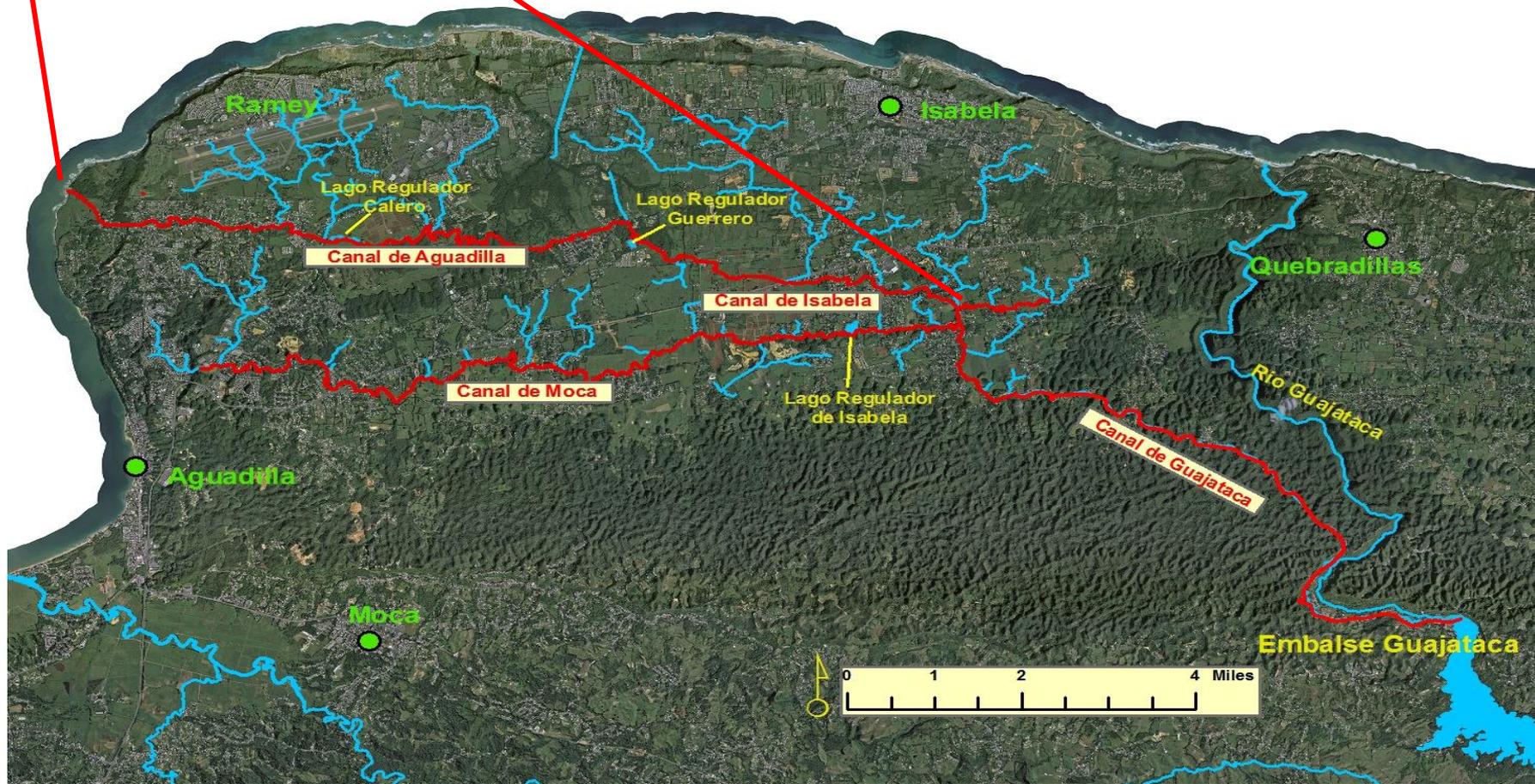
27,500 acres

- JD Channel
- Patillas Channel
- Guamani Channel



Isabela Water District

Completed in 1928



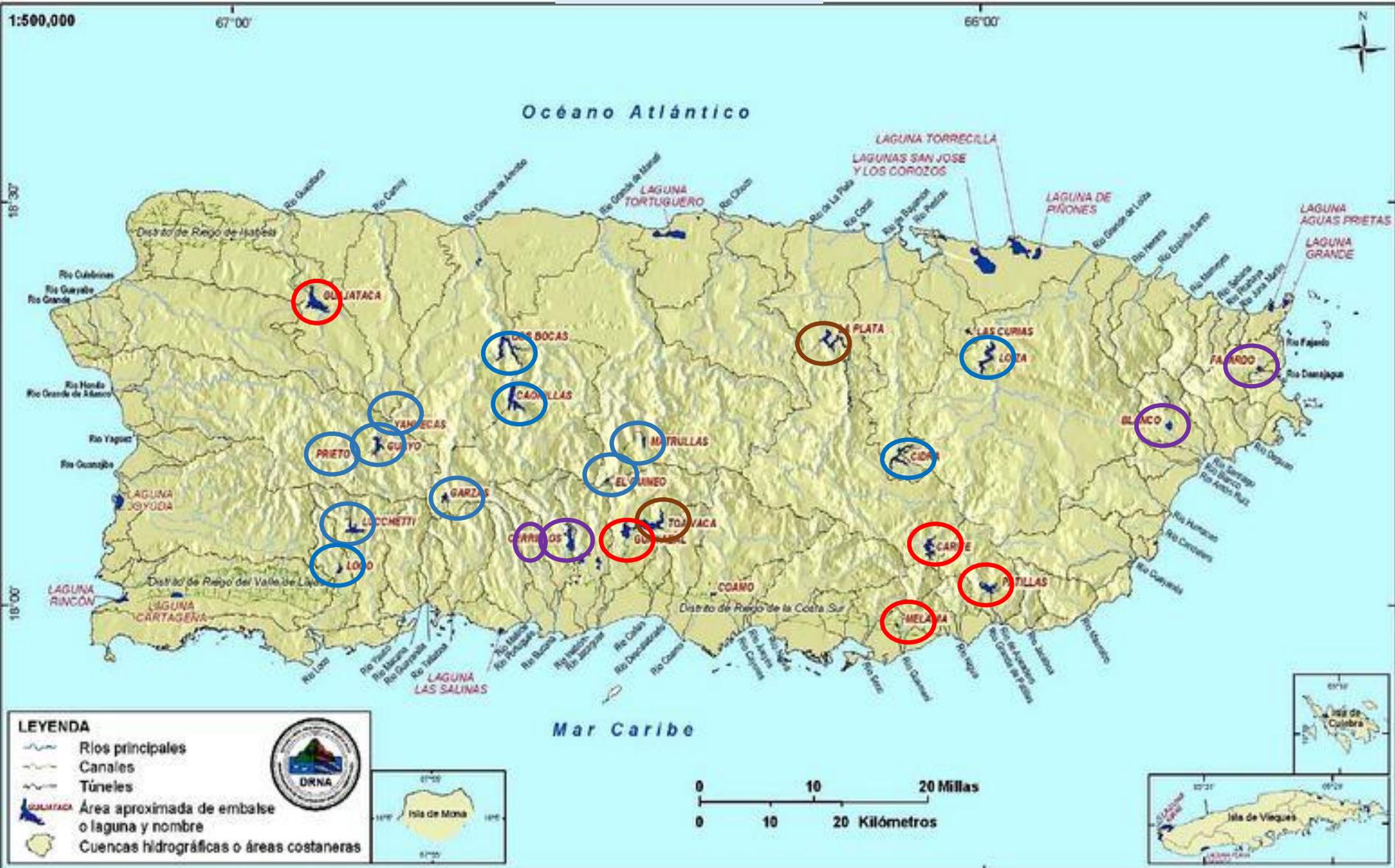
Lajas Valley Water District

Irrigation water for 36,000 acres

- 330 Ag irrigation intakes
- 4 filtration plants

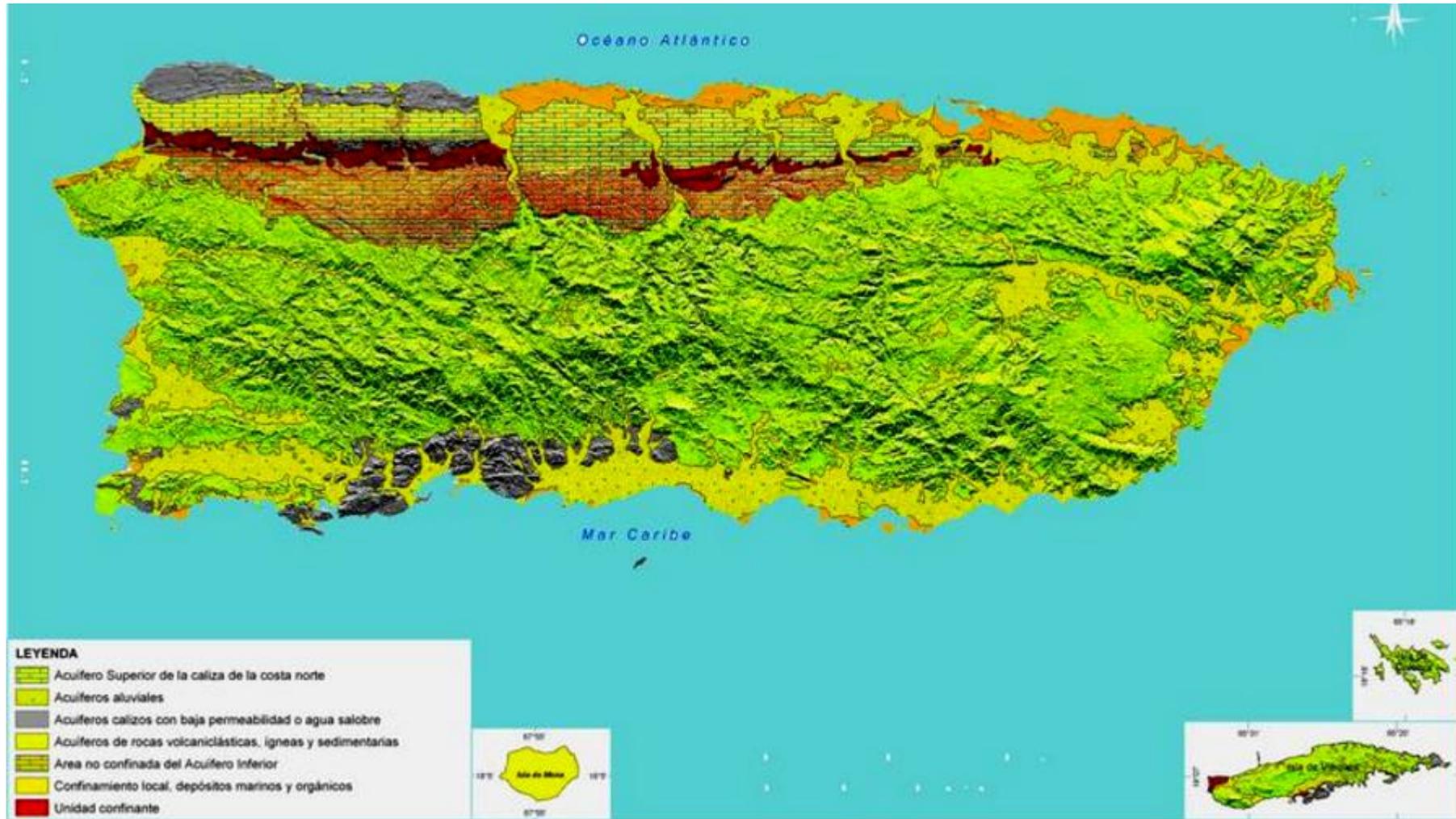


Reservoirs



Fuente: Departamento de Recursos Naturales y Ambientales, 2003

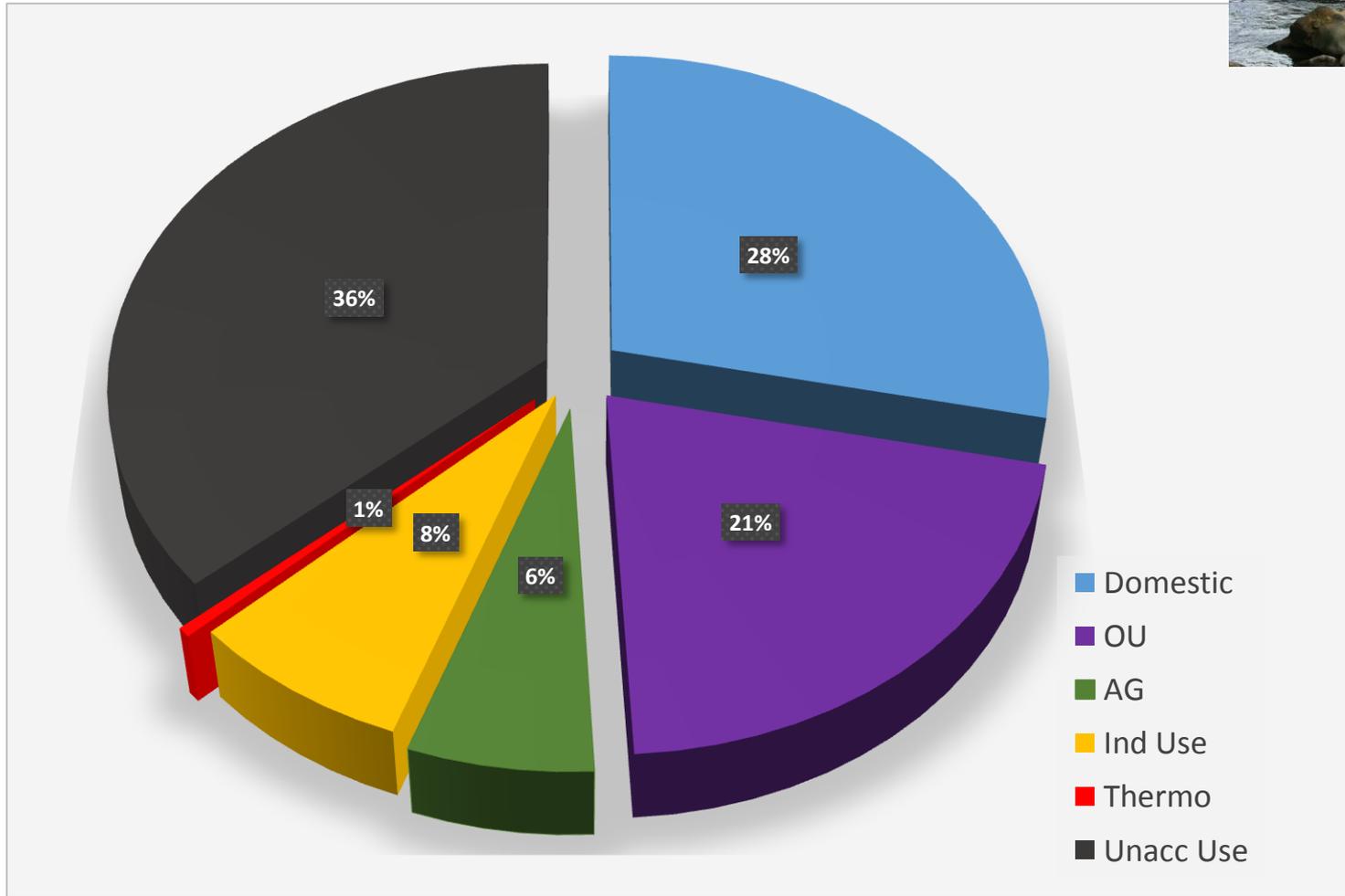
Aquifers



125mgd (20% of total withdrawal)

- North -75mgd
- South -50 mgd

Freshwater Use in Puerto Rico 2010 (mgd)



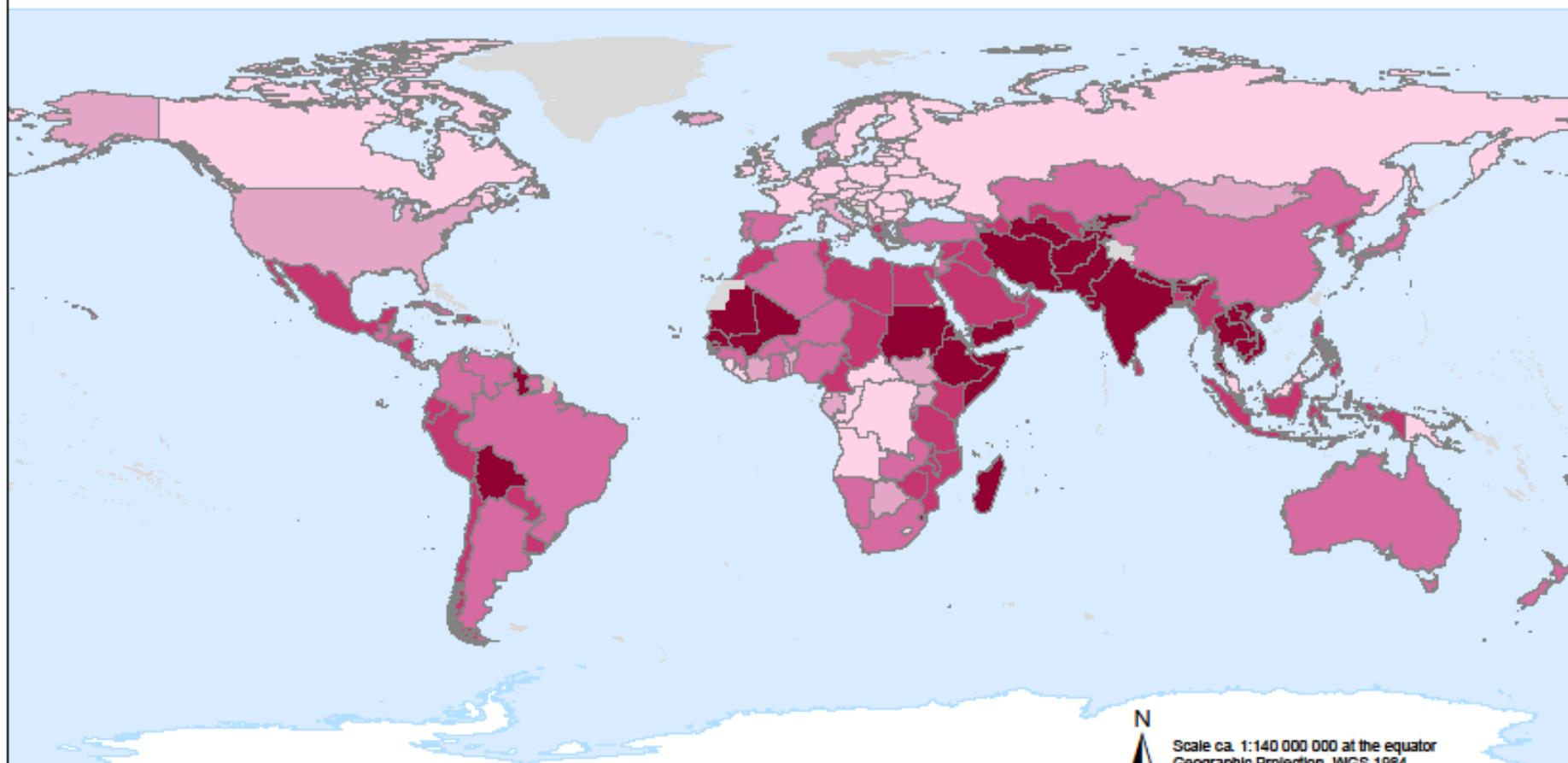
Domestic	207.76
Other Uses	152.76
AG	45.96
Ind Use	56.2
Thermo	3.44
Unacc Use	267.04
	733.16



Food and Agriculture
Organization of the
United Nations

Proportion of total water withdrawal withdrawn for agriculture

Agricultural water withdrawal as percentage of total water withdrawal for agricultural, municipal and industrial purposes



Scale ca. 1:140 000 000 at the equator
Geographic Projection, WGS 1984

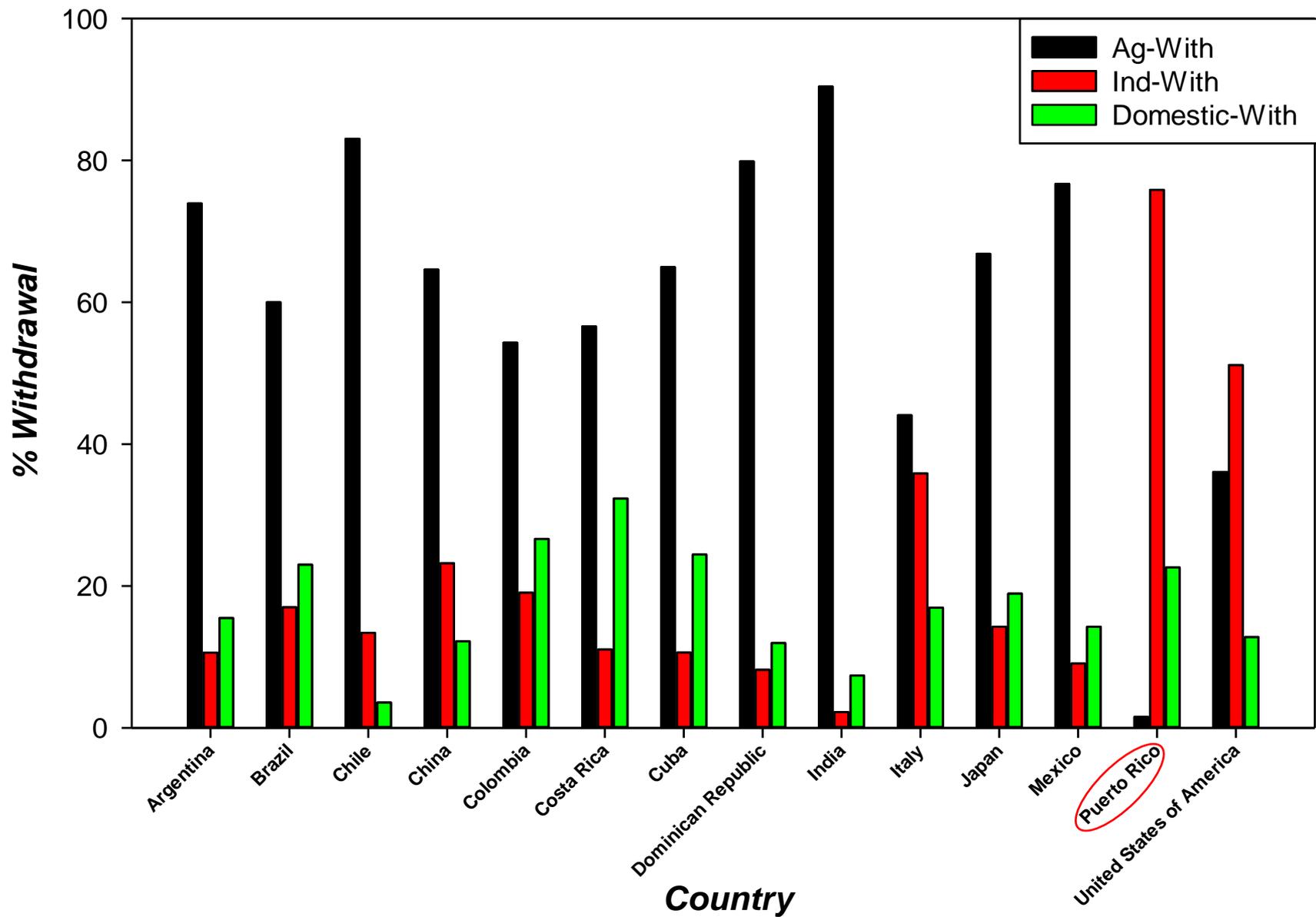
Legend



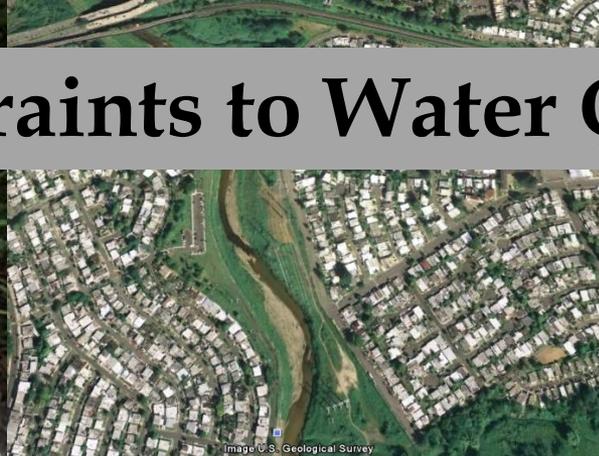
FAO - AQUASTAT, 2015

Source: AQUASTAT
Geographic Projection

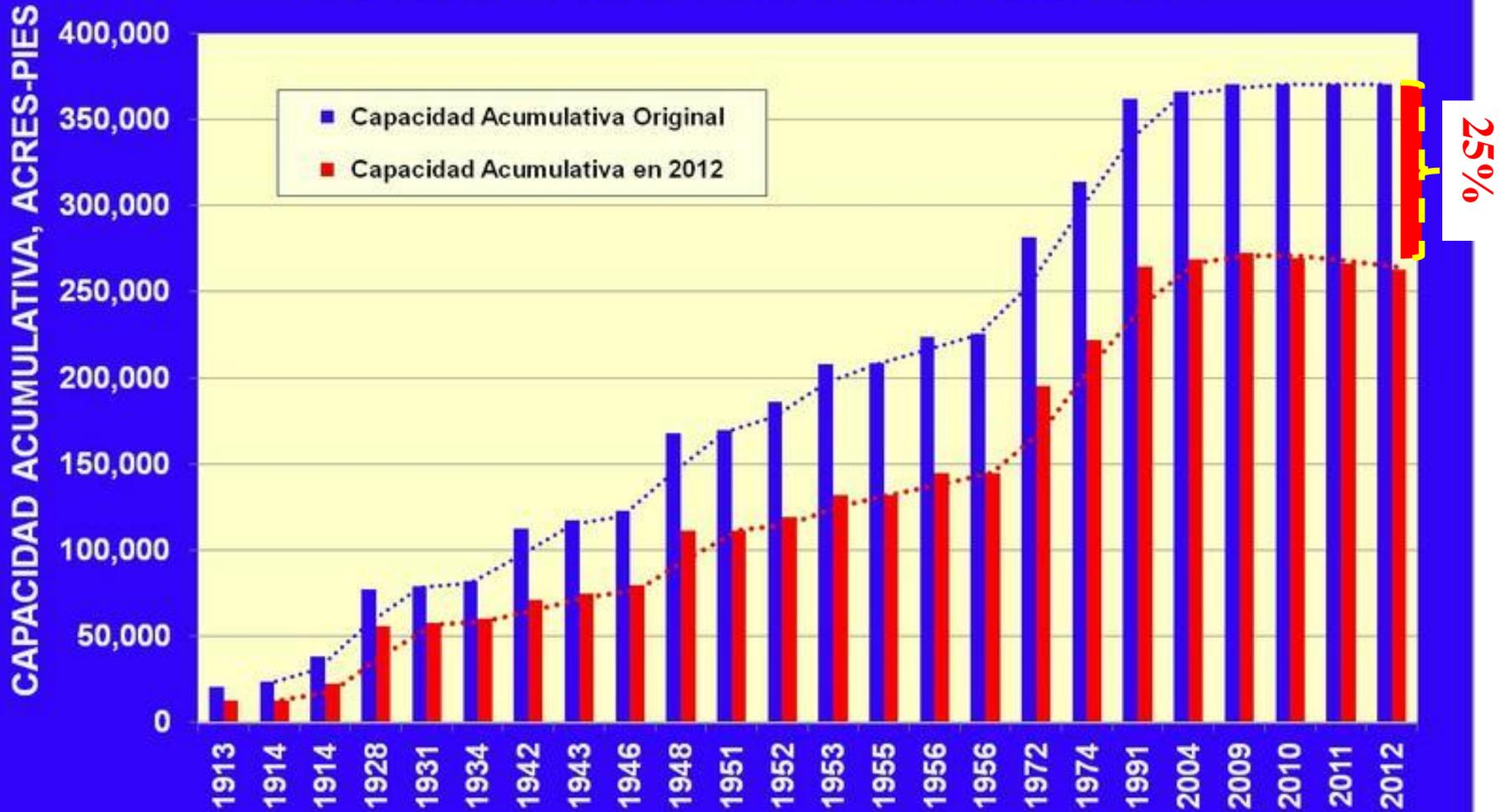
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Constraints to Water Quality



Original vs Current Storage Capacity of Reservoirs of Puerto Rico



25%

SEDIMENTATION



High Threat	Percent loss
Dos Bocas	55
Loíza	47
Lucchetti	42
Guayabal	51
Loco	64

Storage loss: approx.: 10,600 Mgal

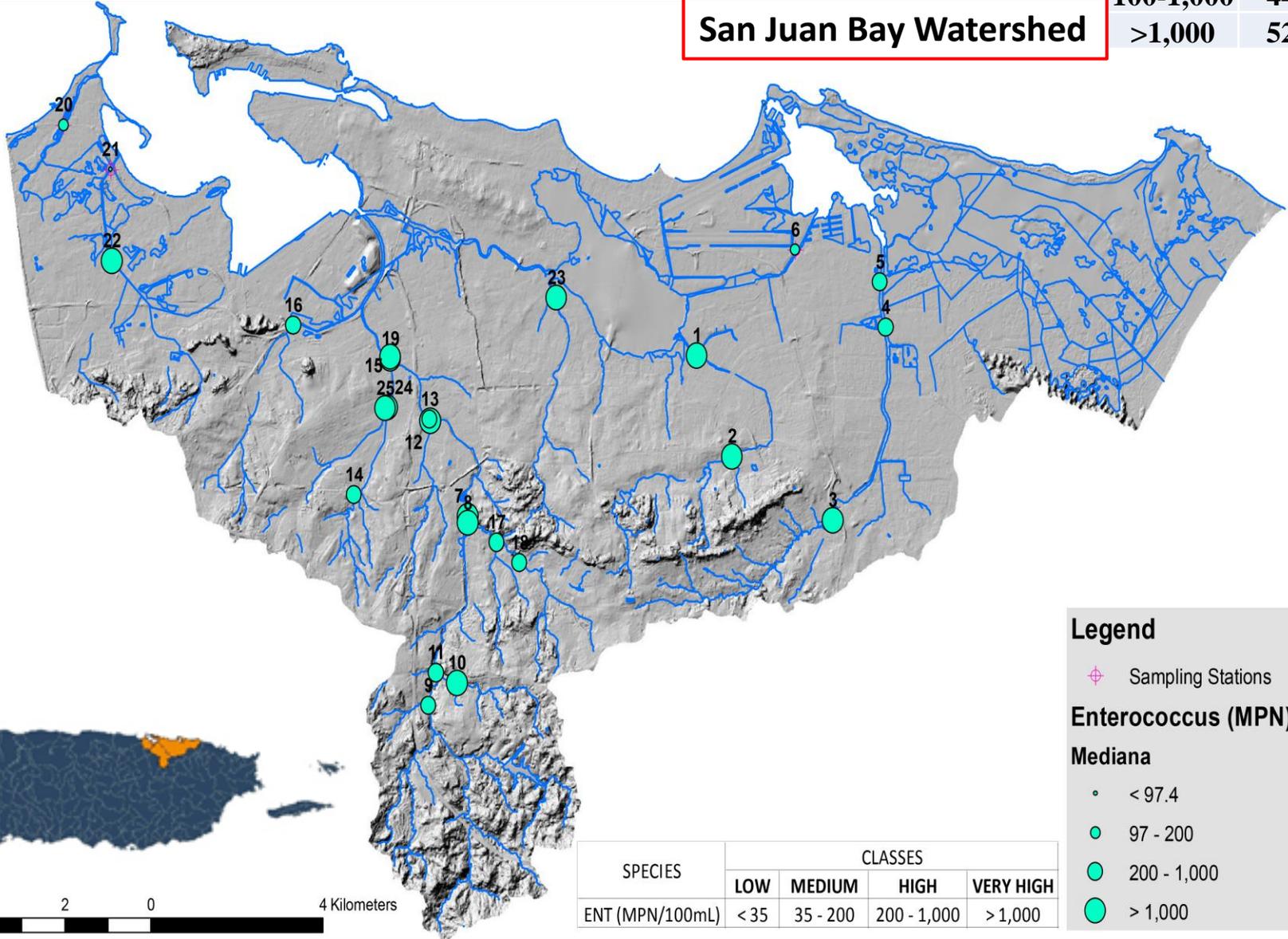
Waterborne Pathogens



Enterococcus (MPN (CFU/100mL))

<35	0%
35-100	4%
100-1,000	44%
>1,000	52%

San Juan Bay Watershed



Legend

- ⊕ Sampling Stations

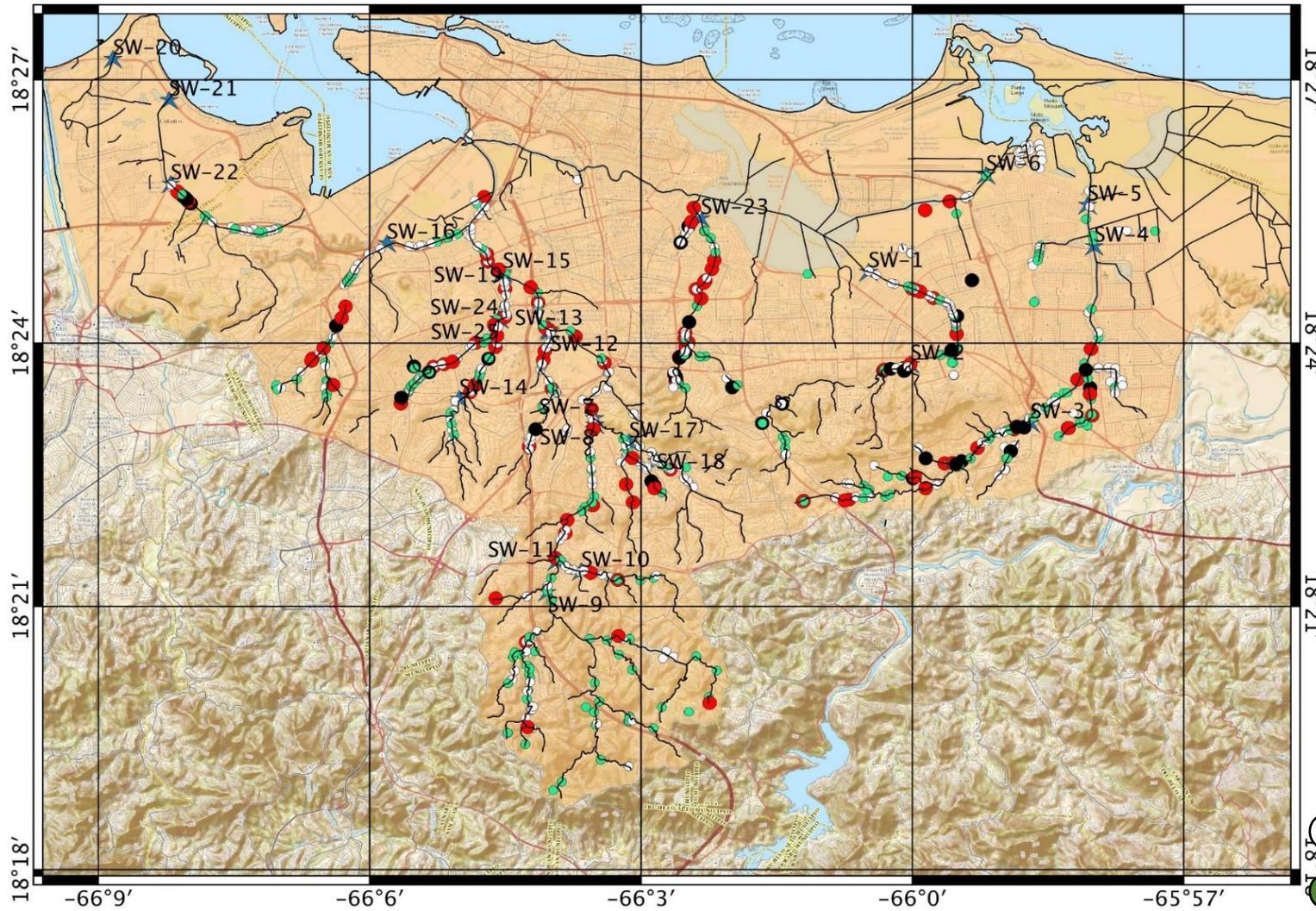
Enterococcus (MPN)

Mediana

- < 97.4
- 97 - 200
- 200 - 1,000
- > 1,000

SPECIES	CLASSES			
	LOW	MEDIUM	HIGH	VERY HIGH
ENT (MPN/100mL)	< 35	35 - 200	200 - 1,000	> 1,000

Color code classification of inventoried outfalls



LEGEND

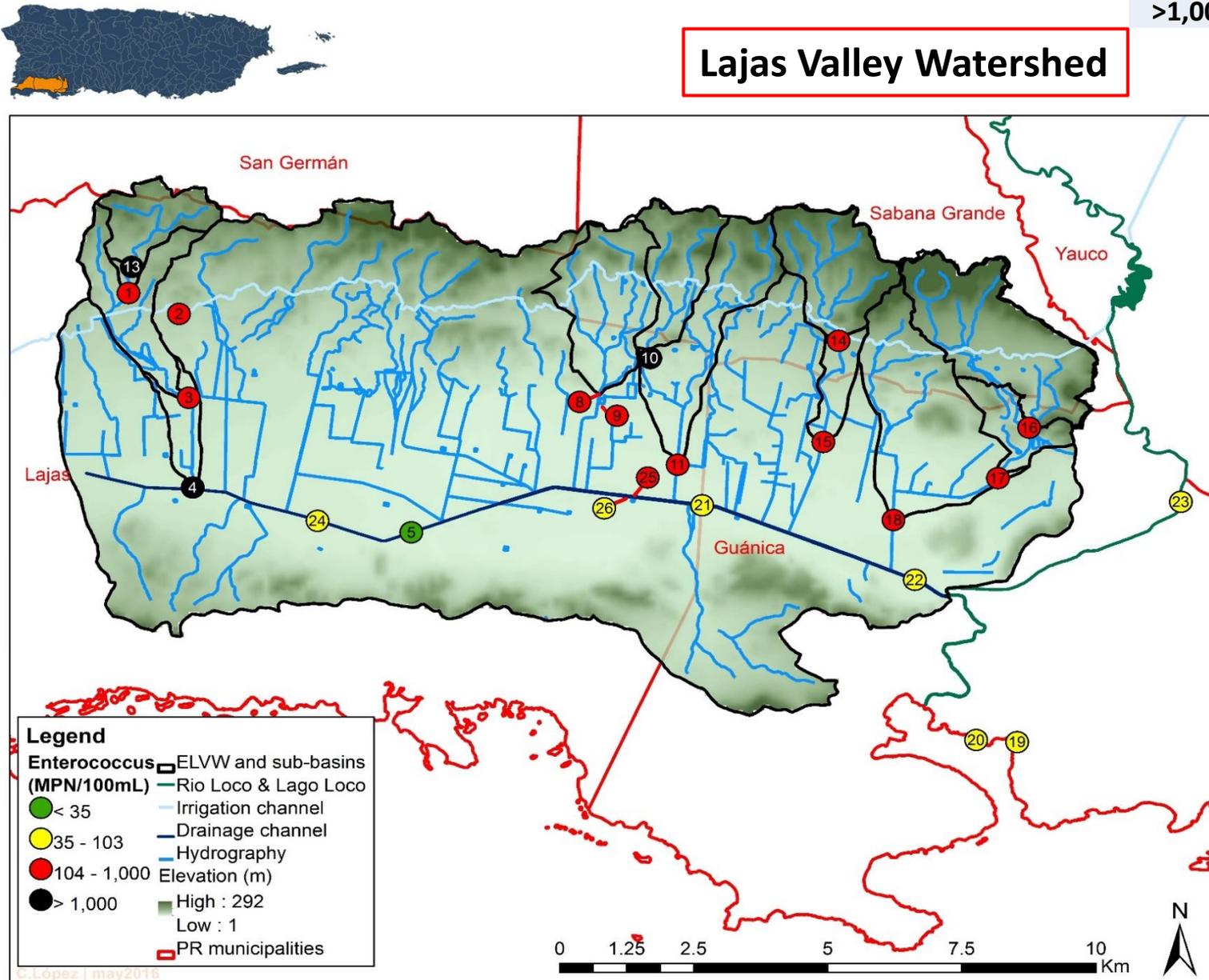
-  Non Flowing outfall
-  Sanitary presence unlikely
-  Confirmed Suspect
-  Evident Sanitary Effluent



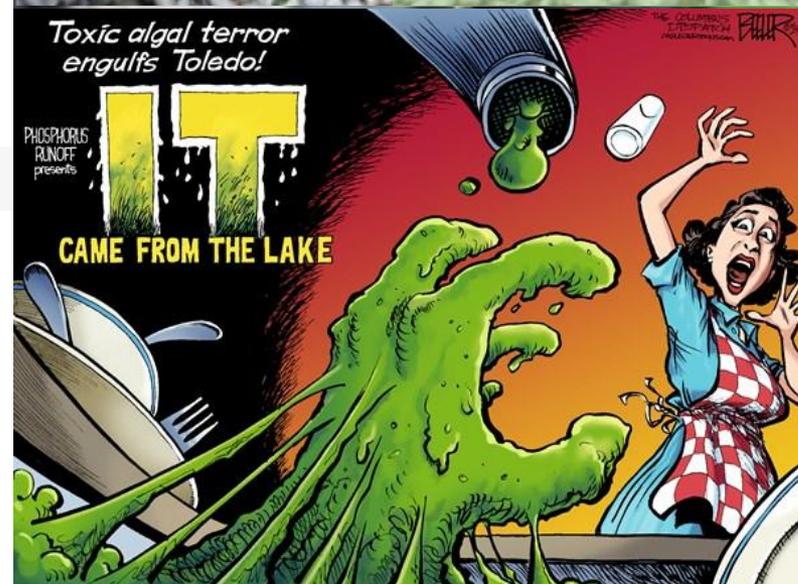
Enterococcus (MPN (CFU/100mL))

<35	4.35%
35-100	30.43%
100-1,000	52.17%
>1,000	8.70%

Lajas Valley Watershed



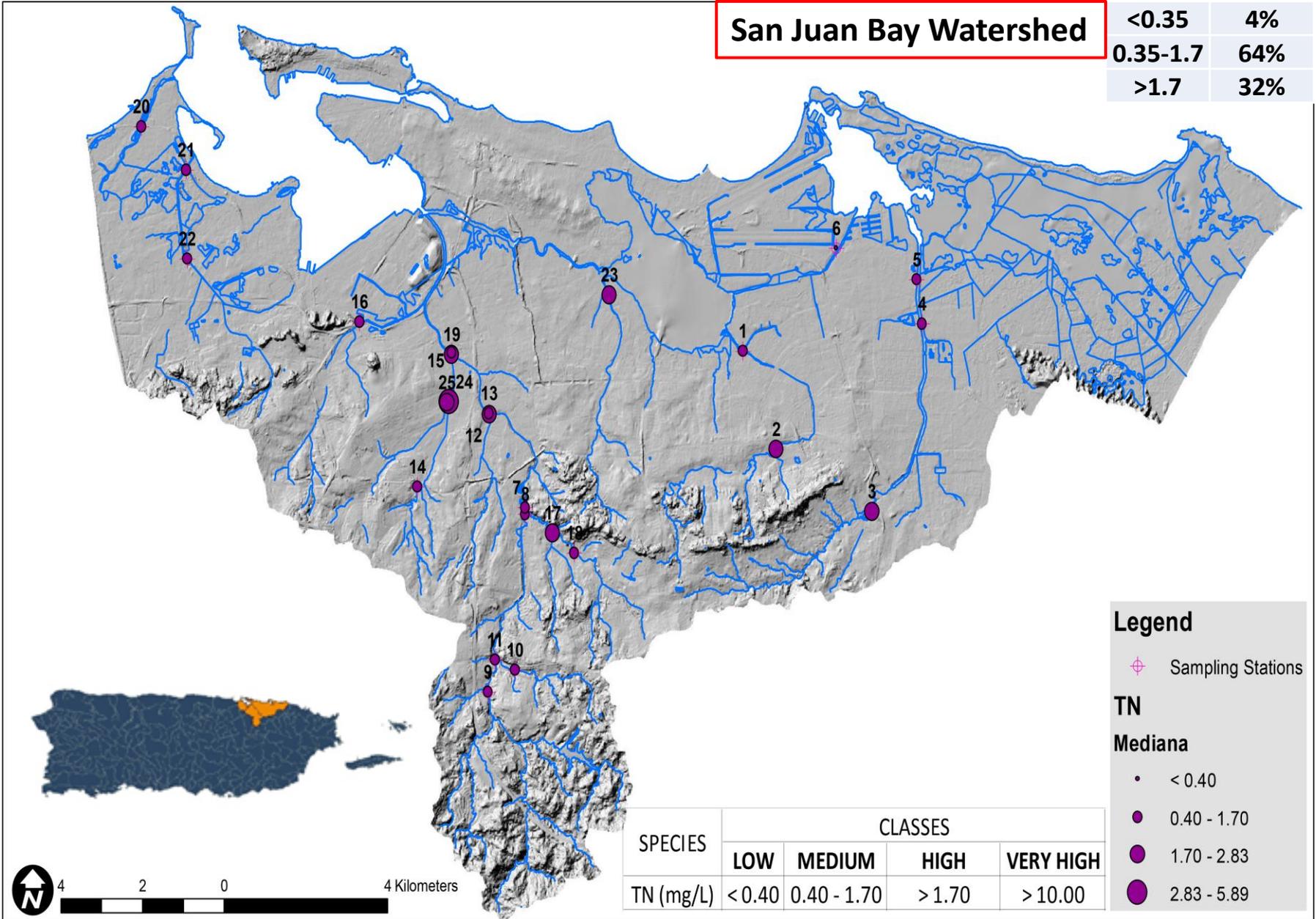
Eutrophication: excessive primary productivity as result of excessive nutrient loadings



TOTAL NITROGEN (mg/L)

San Juan Bay Watershed

<0.35	4%
0.35-1.7	64%
>1.7	32%



Legend

⊕ Sampling Stations

TN

Mediana

- < 0.40
- 0.40 - 1.70
- 1.70 - 2.83
- 2.83 - 5.89

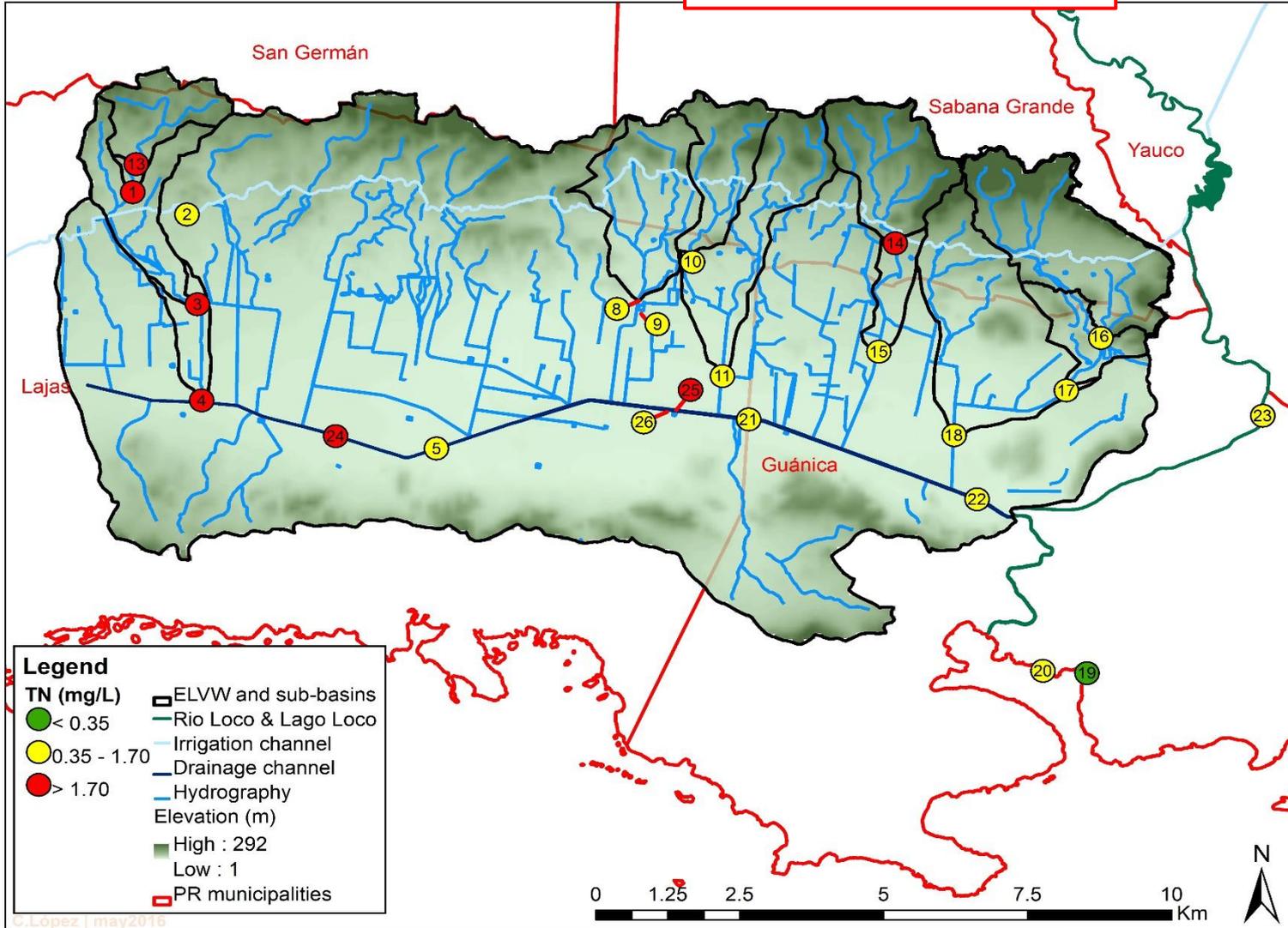
SPECIES	CLASSES			
	LOW	MEDIUM	HIGH	VERY HIGH
TN (mg/L)	< 0.40	0.40 - 1.70	> 1.70	> 10.00



TOTAL NITROGEN (mg/L)

<0.35	4.35%
0.35-1.7	65.21%
>1.7	30.43%

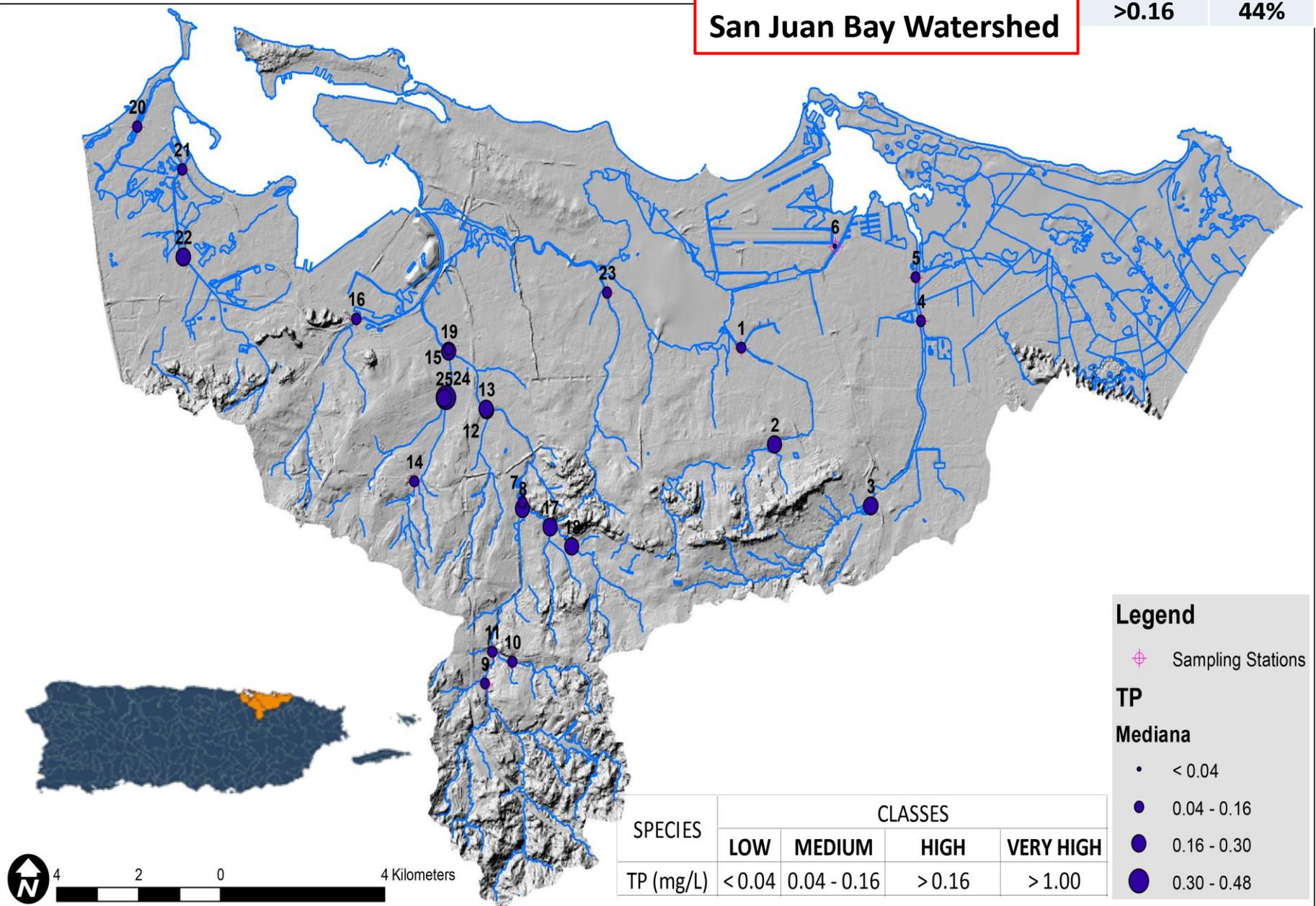
Lajas Valley Watershed



TOTAL PHOSPHORUS (mg/L)

<0.030	4%
0.030-0.16	52%
>0.16	44%

San Juan Bay Watershed



Legend

⊕ Sampling Stations

TP

Mediana

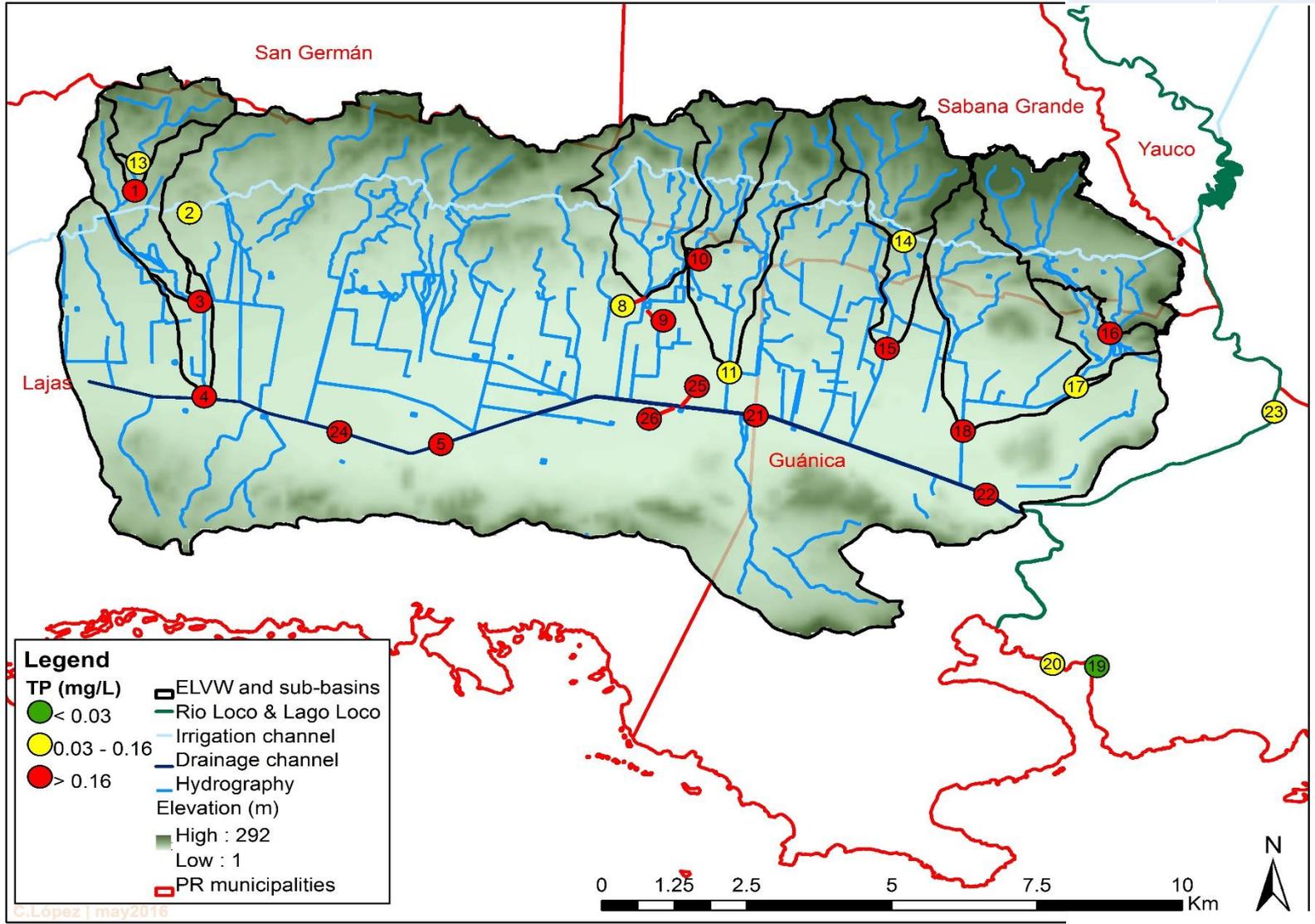
- < 0.04
- 0.04 - 0.16
- 0.16 - 0.30
- 0.30 - 0.48

SPECIES	CLASSES			
	LOW	MEDIUM	HIGH	VERY HIGH
TP (mg/L)	<0.04	0.04 - 0.16	>0.16	> 1.00



TOTAL PHOSPHORUS (mg/L)

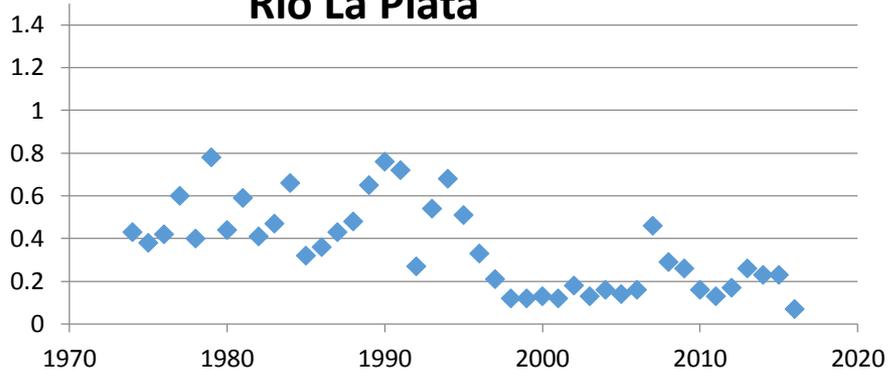
<0.030	4.35%
0.030-0.16	34.78%
>0.16	60.87%



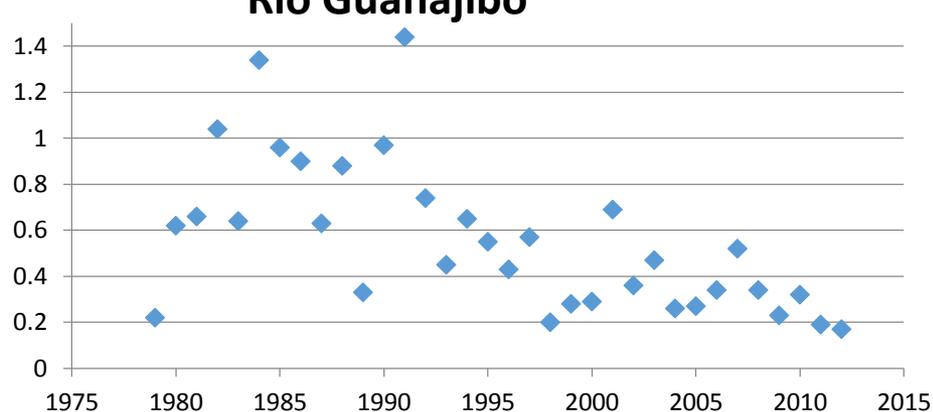
Lajas Valley Watershed



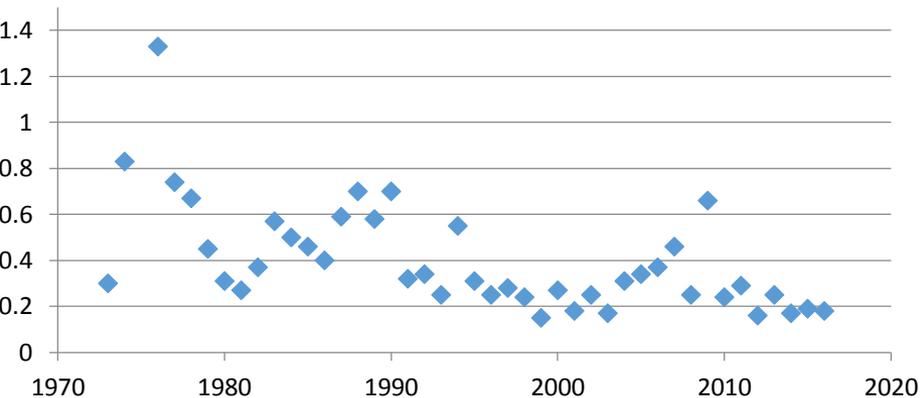
Rio La Plata



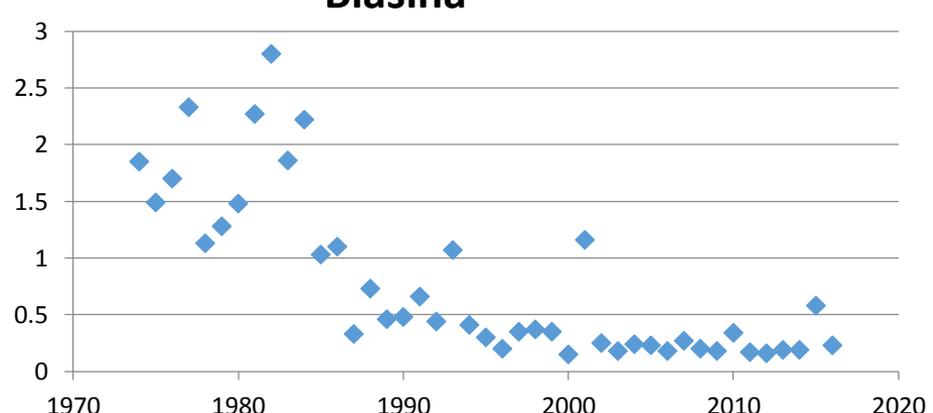
Rio Guanajibo



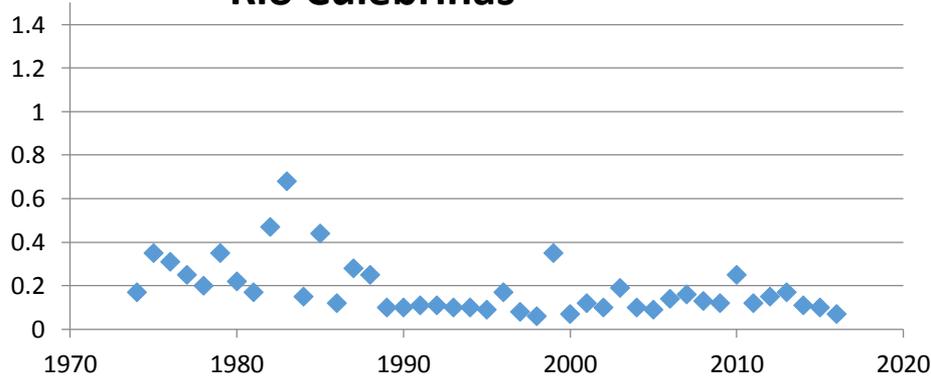
Rio Piedras



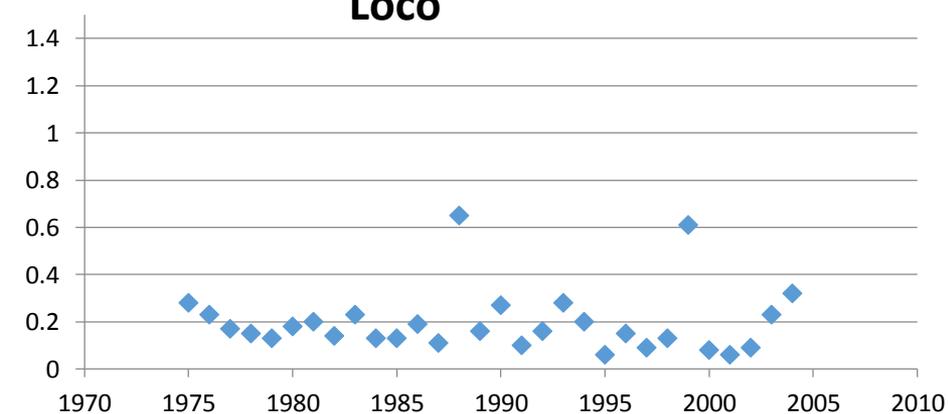
Blasina



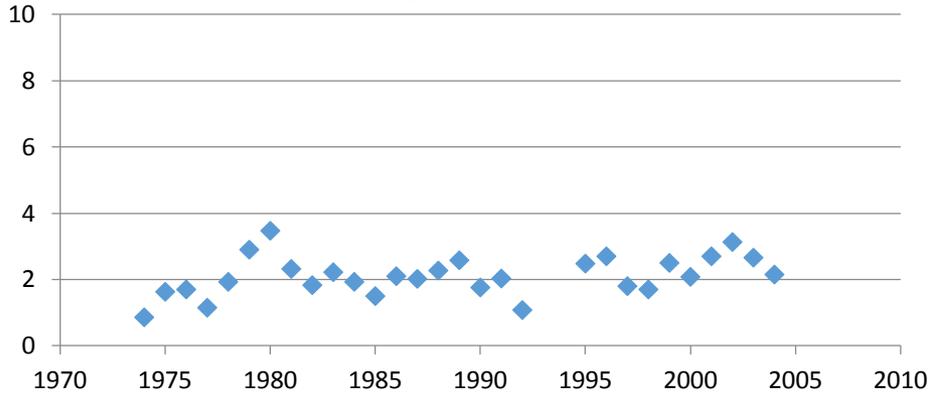
Rio Culebrinas



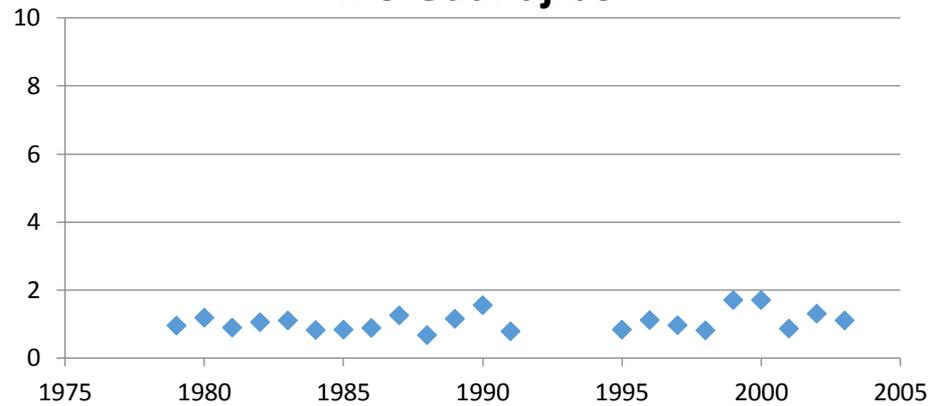
Loco



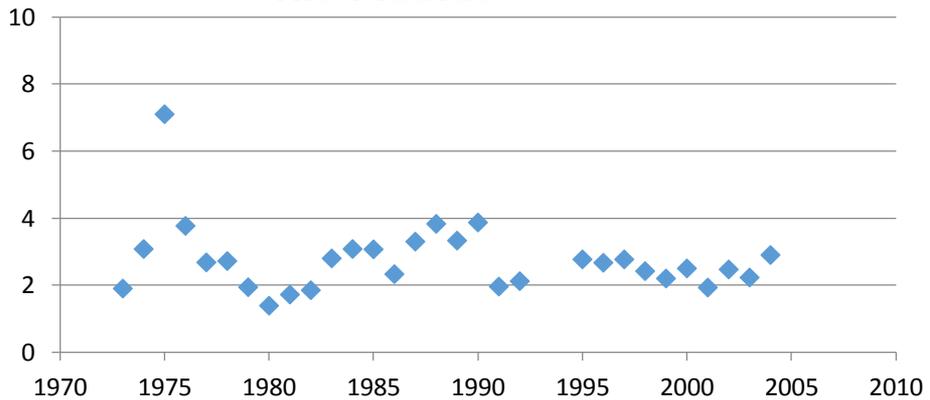
Rio La Plata



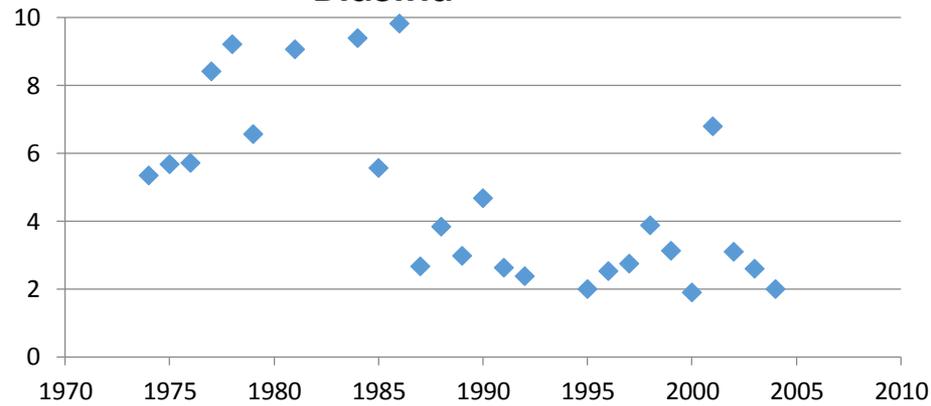
Rio Guanajibo



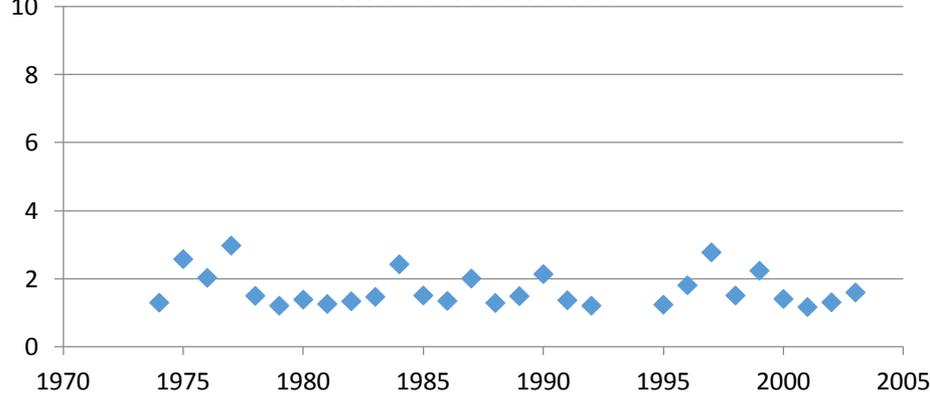
Rio Piedras



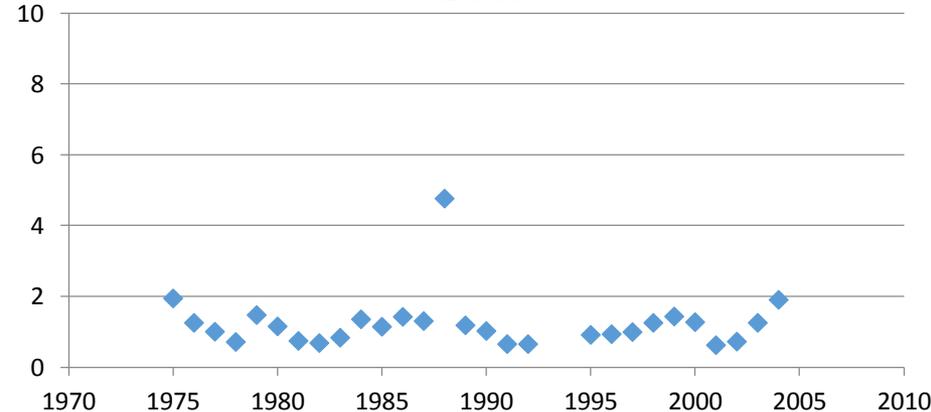
Blasina



Rio Culebrinas



Loco



Climate Change??

Puerto Rico (1940 – 2015)

Wettest Years		Driest Years	
Year	Inches	Year	Inches
1960	103.74	1967	44.31
1963	90.2	1994	46.79
1979	88.92	1997	49.51
2011	88.55	1976	49.93
1961	88.36	1991	50.49
2003	87.78	2015	51.64
1970	87.38	1957	53.47
1998	85.25	1947	54.77
2010	83.51	1973	54.94
2005	83.37	2000	58.04

San Juan Metro (1898-2015)

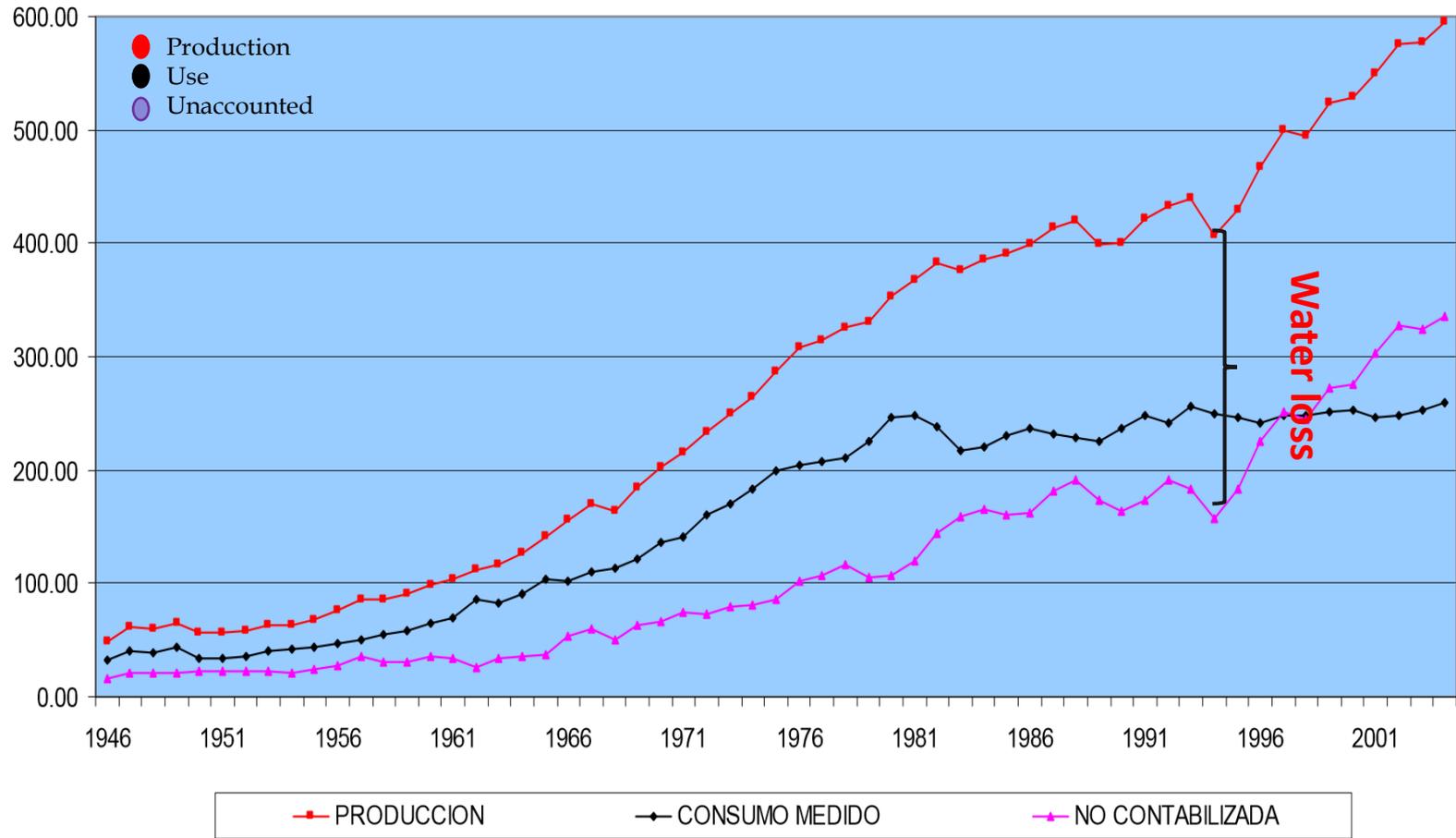
Wettest Years		Driest Years	
Year	Inches	Year	Inches
2010	89.50	1991	35.53
2011	88.14	1971	35.58
1931	87.55	1980	35.95
2013	85.12	1972	37.72
1950	84.97	2000	39.77
1927	84.93	1997	40.85
1902	78.96	1994	40.98
1899	77.61	2015	41.30
2005	77.28	1974	41.68
1952	76.60	1983	41.90

50% of the driest/wettest years in recorded history have occurred since 1990

2015 Drought



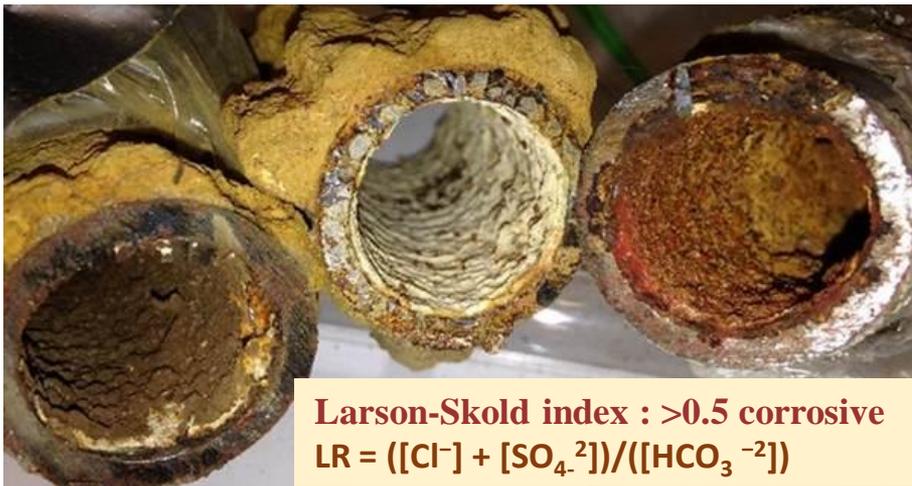
Water Production, Use, and System Efficiency In Puerto Rico



Potable Water Quality!!

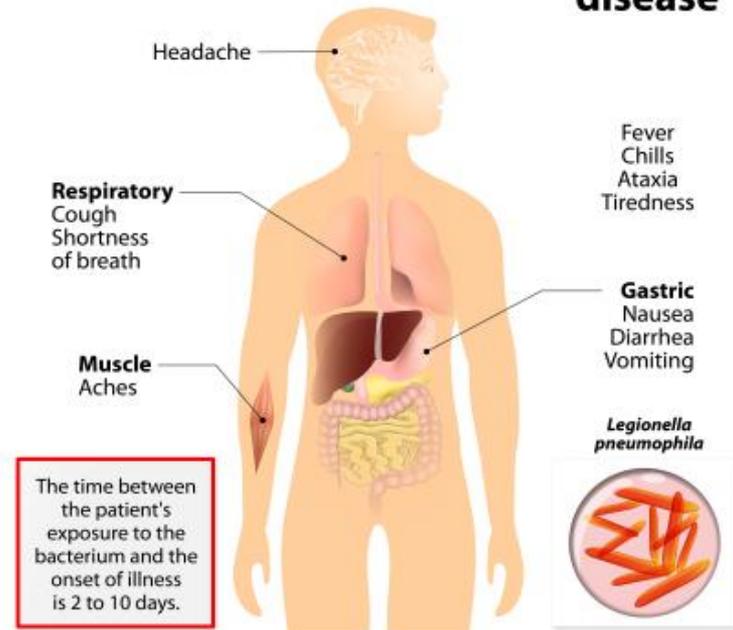
FLINT DIRTY WATER

WHO'S TO BLAME?
EXAMINE THE FACTS.



Larson-Skold index : >0.5 corrosive
 $LR = ([Cl^-] + [SO_4^{2-}]) / ([HCO_3^{-2}])$

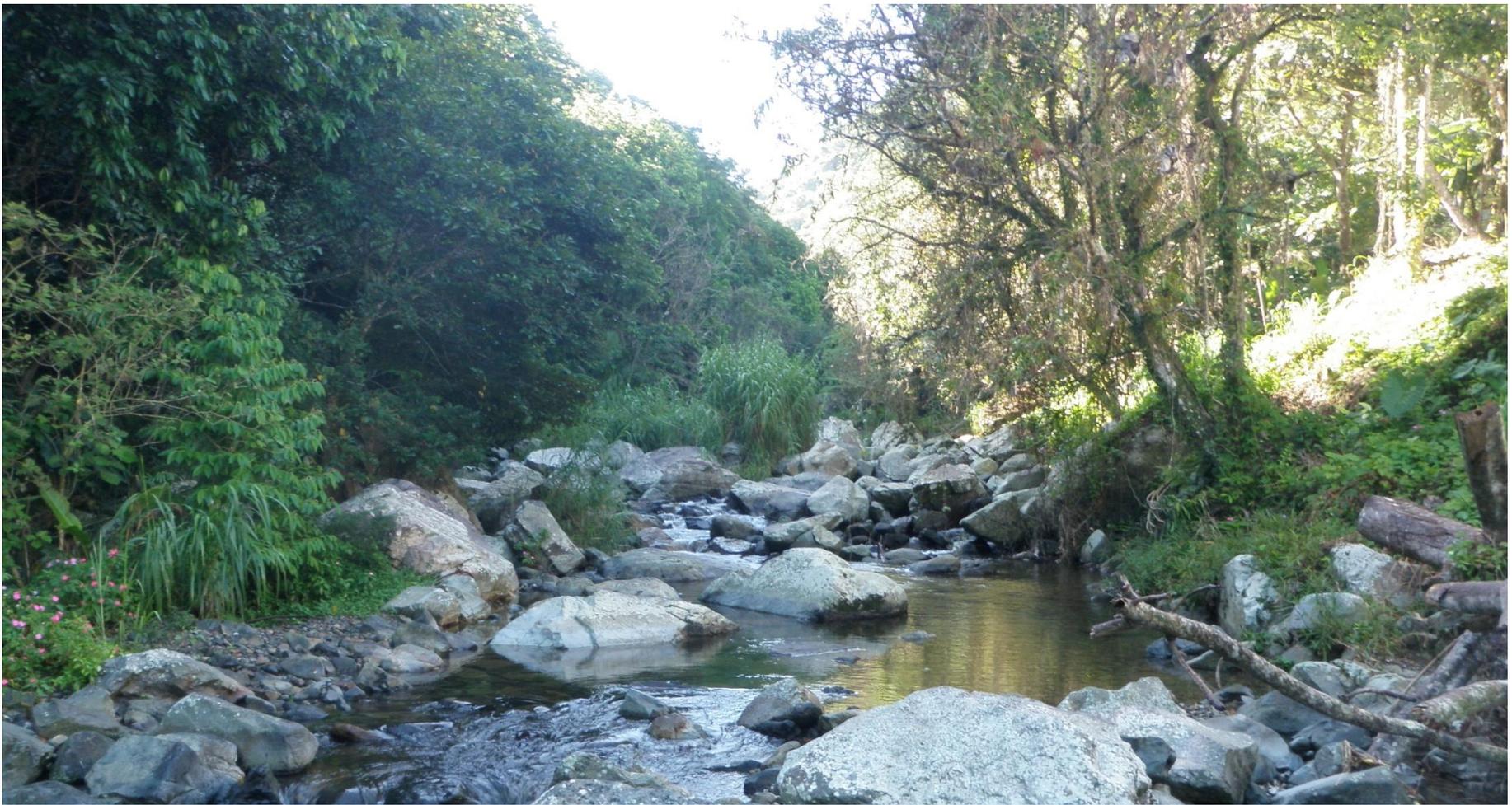
Legionnaires' disease



The time between the patient's exposure to the bacterium and the onset of illness is 2 to 10 days.

Legionella pneumophila

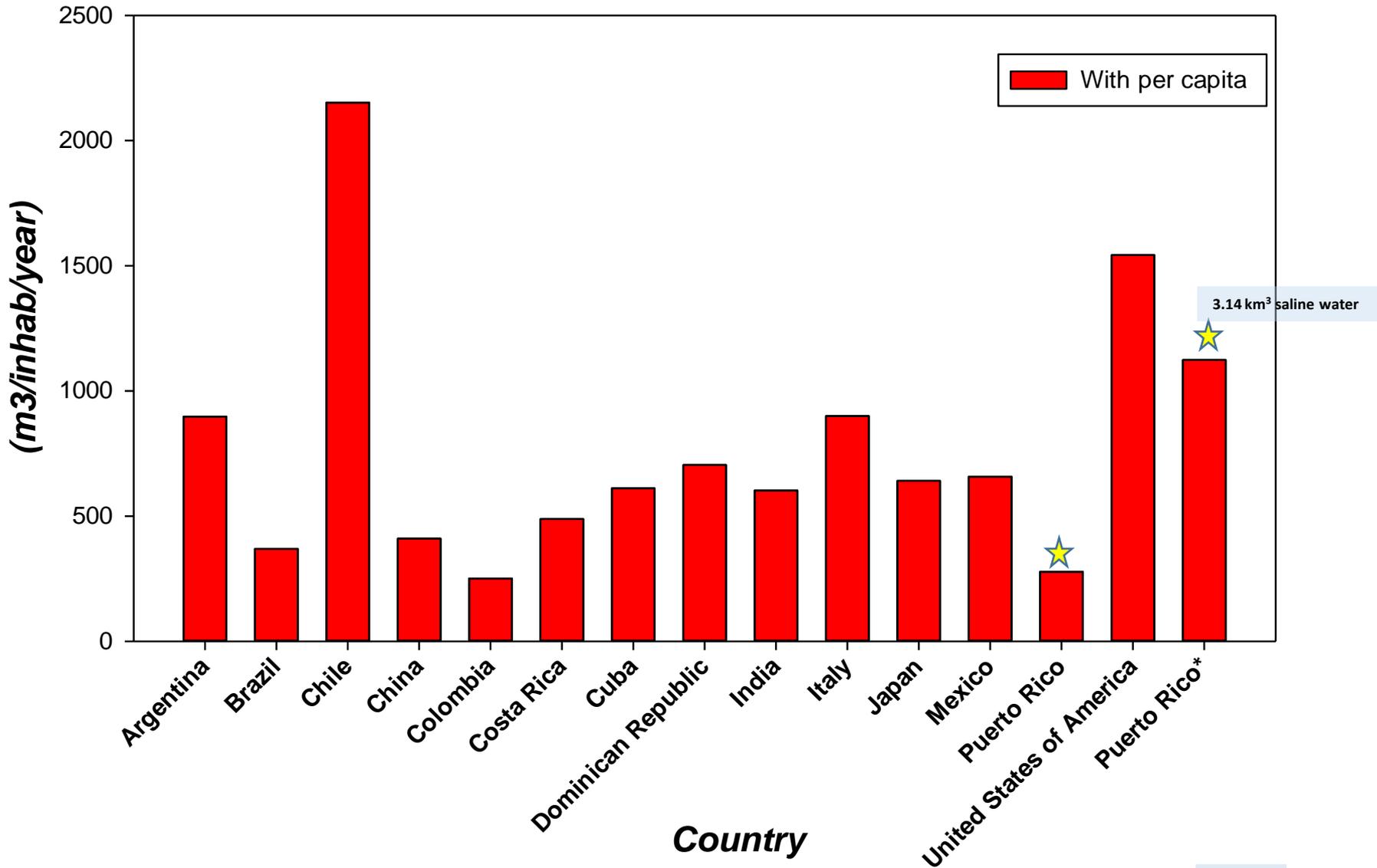


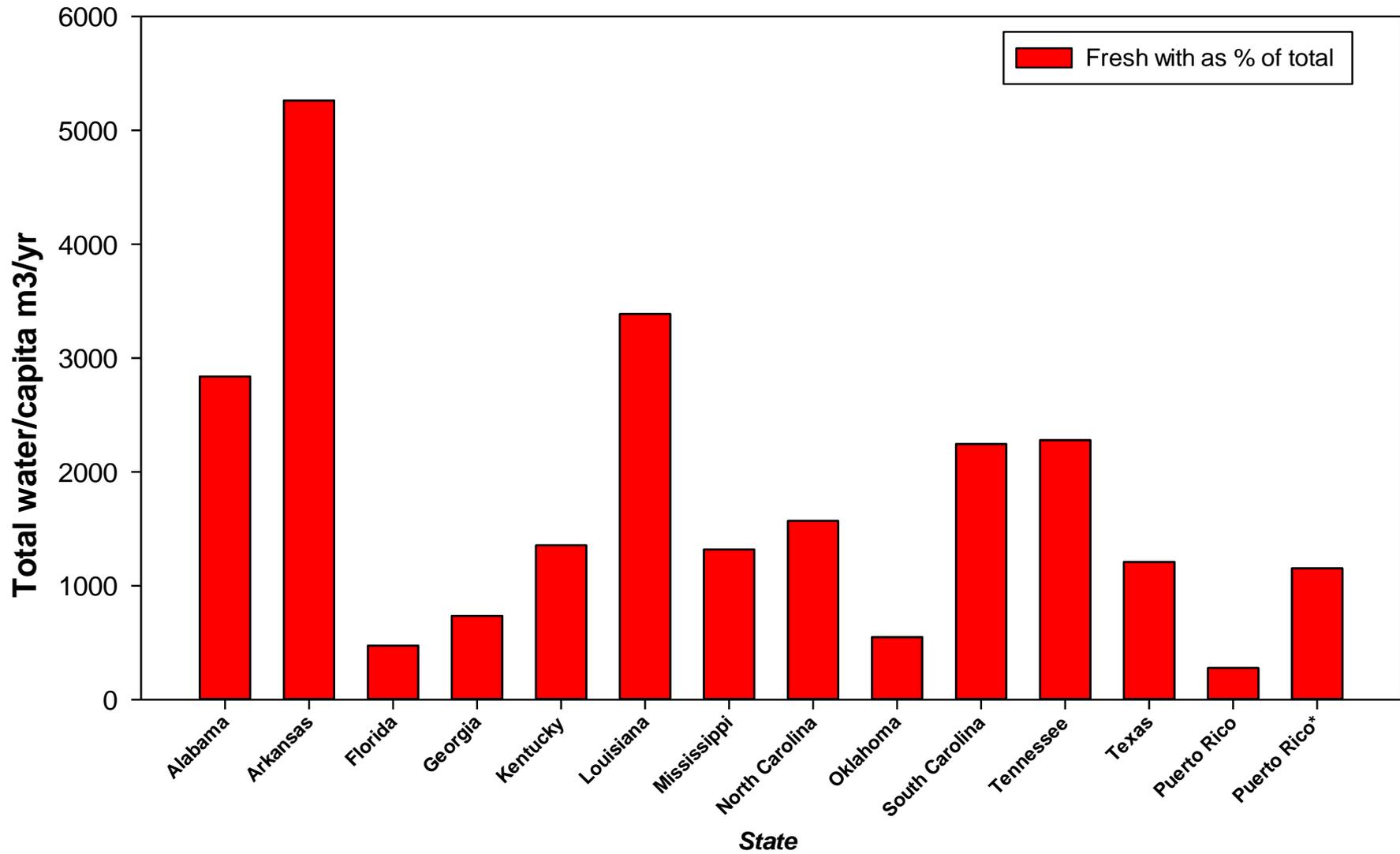


For more Info:

- <http://www.recursosaguapuertorico.com>
- <http://pr.water.usgs.gov/>
- <http://drna.pr.gov/oficinas/plan-integral-de-recursos-de-agua-de-puerto-rico/>

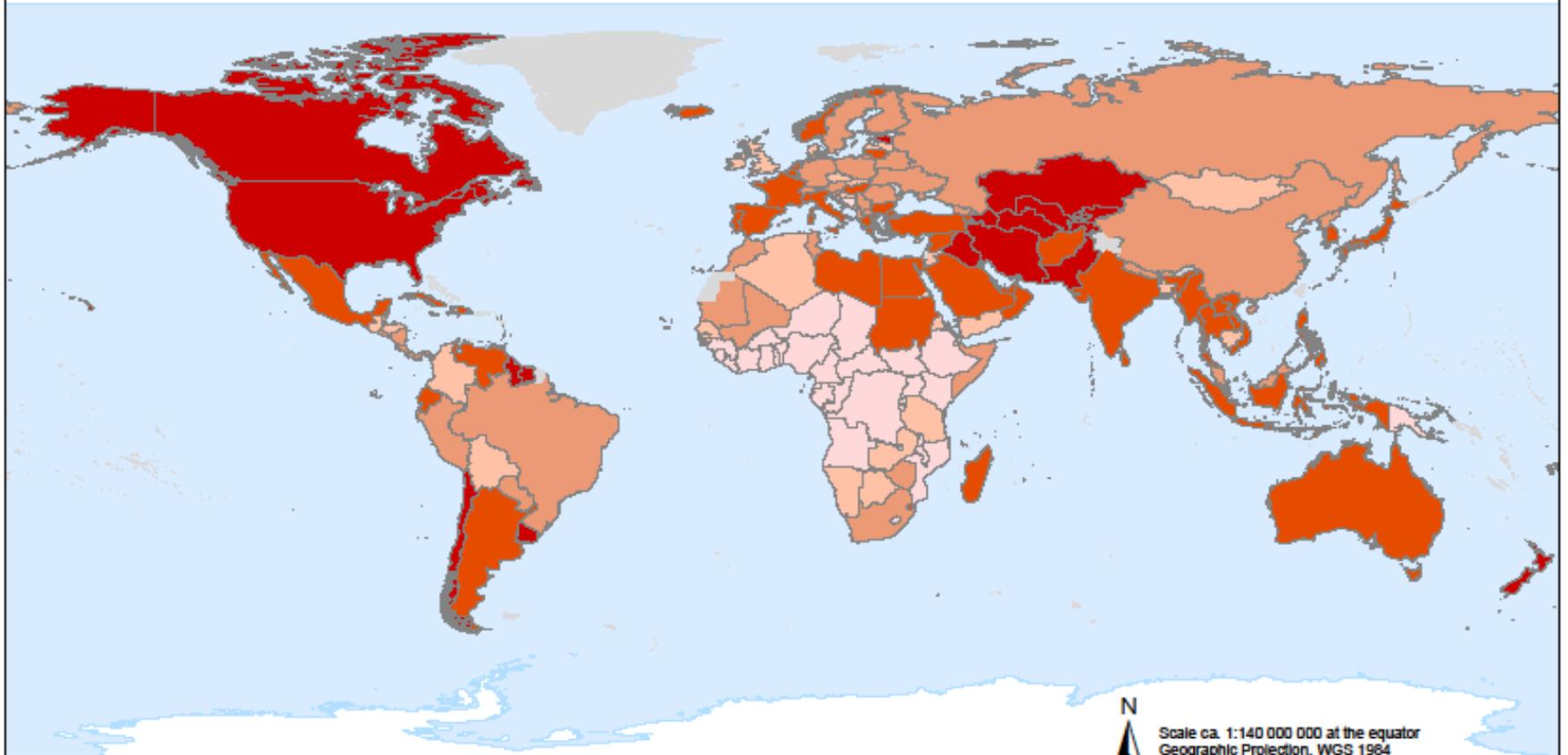








Water withdrawal per inhabitant (m³/year)



Scale ca. 1:140 000 000 at the equator
Geographic Projection, WGS 1984

Legend



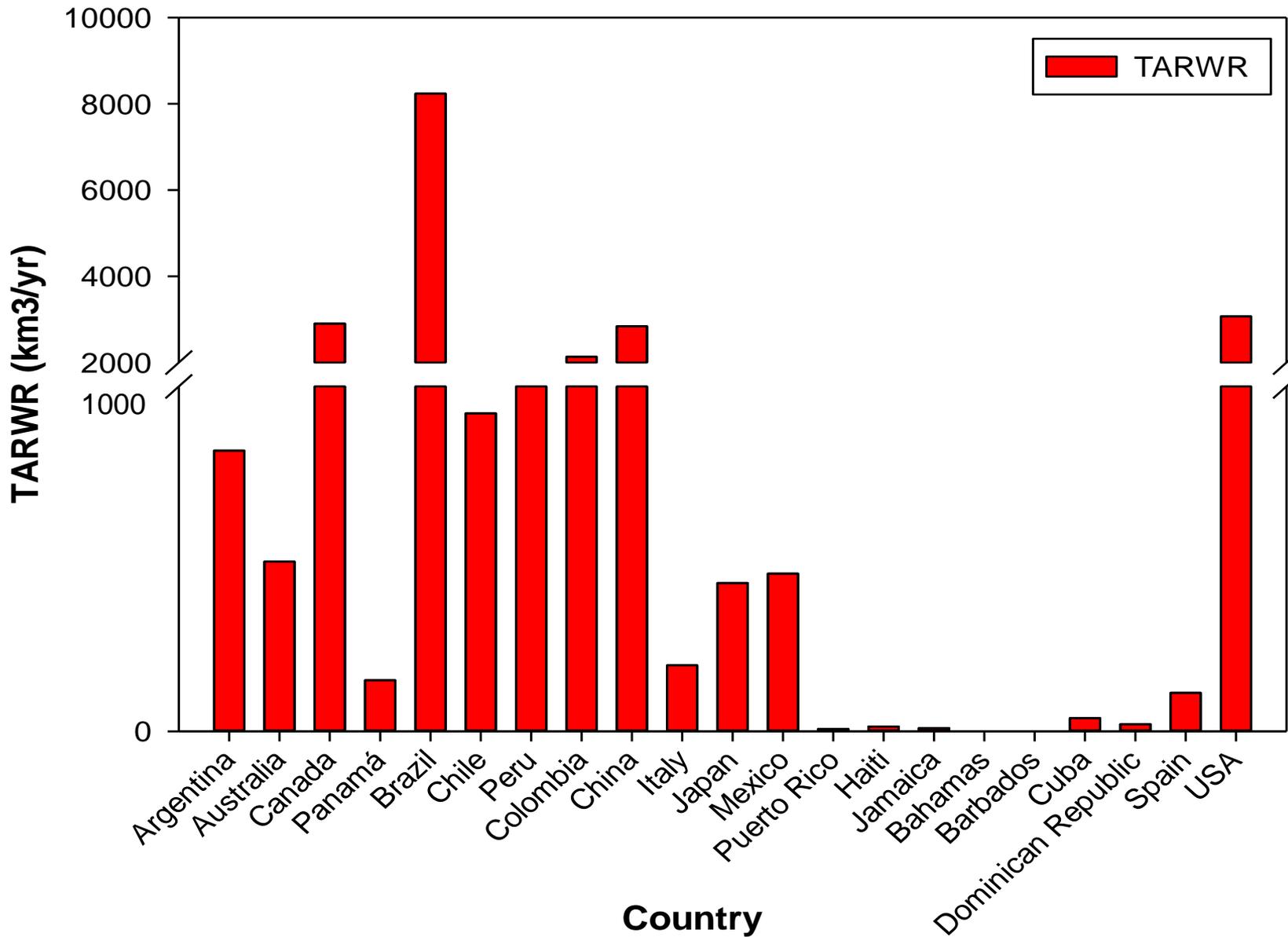
Source: AQUASTAT
Geographic Projection

FAO - AQUASTAT, 2015

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Total Renewable Freshwater Resources

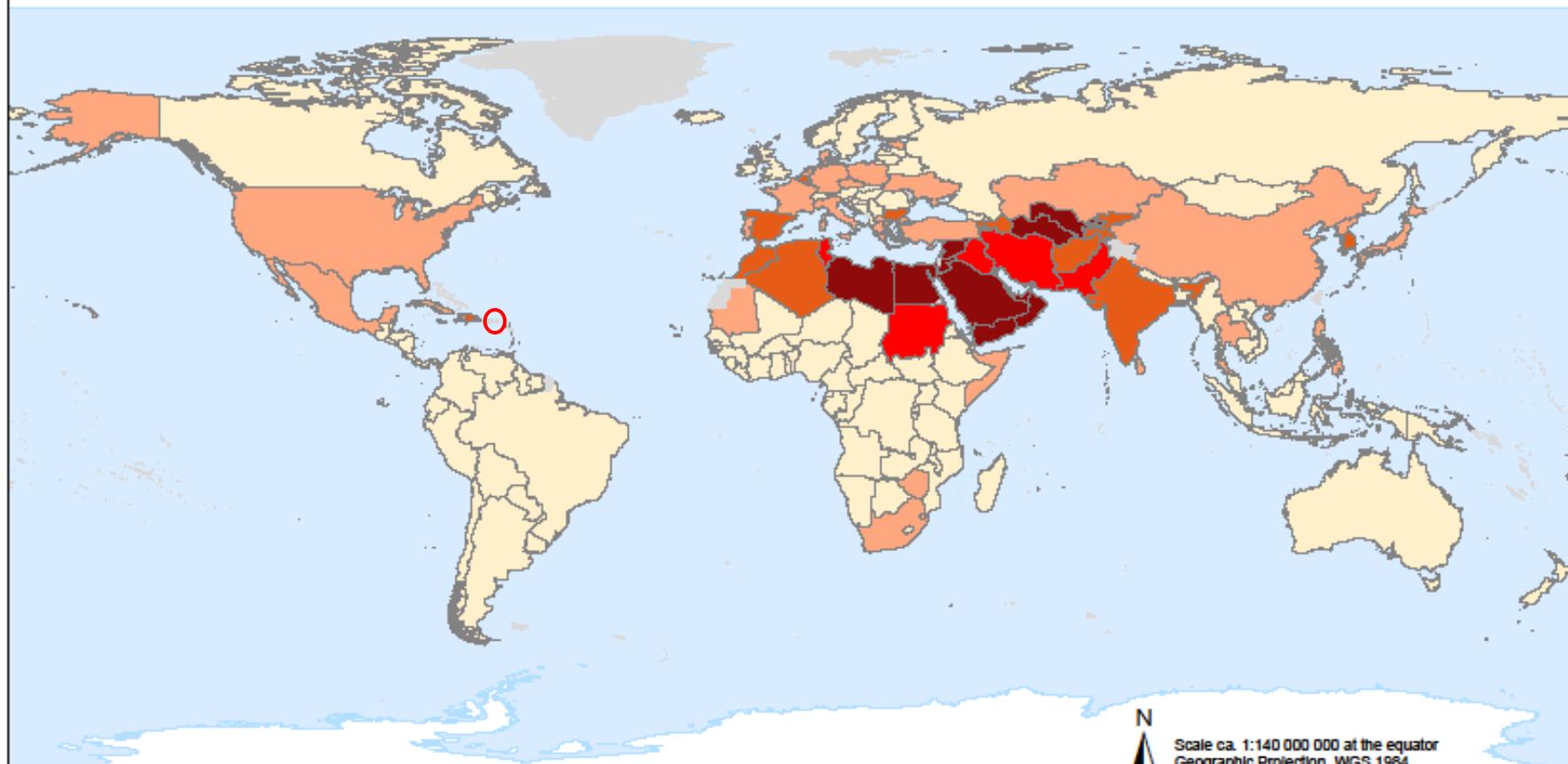




Food and Agriculture
Organization of the
United Nations

Proportion of renewable water resources withdrawn: MDG Water Indicator

Millennium Development Goal (MDG) Water Indicator 7.5



Legend



Source: AQUASTAT
Geographic Projection

FAO - AQUASTAT, 2015

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